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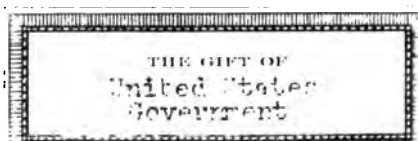
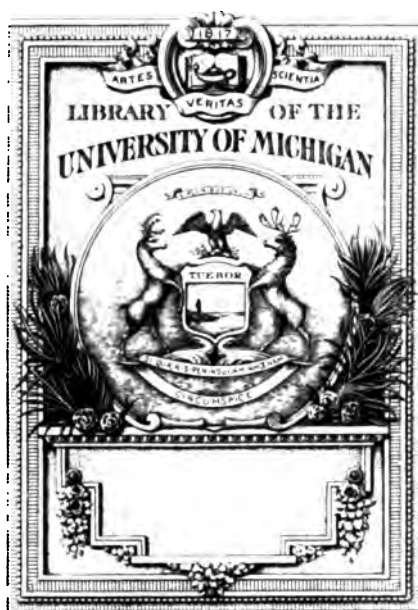
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DEPARTMENT OF THE INTERIOR

ALBERT B. FALL, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

FORTY-THIRD ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES
GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR

ENDED JUNE 30

1922



WASHINGTON

GOVERNMENT PRINTING OFFICE

1912



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Directors of the U. S. Geological Survey

CLARENCE KING, 1879-1881
JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894
GEORGE OTIS SMITH, 1907-

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PLATE I. Areas covered by topographic surveys made by United States Geological Survey prior to July 1, 1921

FORTY-THIRD ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

APPROPRIATIONS.

The direct appropriations for the work under the Geological Survey for the fiscal year 1922 comprised items amounting to \$1,614,340. In addition \$140,000, to be disbursed under the direction of the Public Printer, was appropriated for printing the reports of the Survey, and allotments of \$10,000 and \$7,423.96 for miscellaneous printing and binding and for miscellaneous supplies, respectively, were made from Interior Department appropriations.

GENERAL SUMMARY.

The wide range of the Geological Survey's work is shown by the following outline of the tasks accomplished during the year. The reports of the several branches set forth the work in detail. In the fiscal year 1922 the Survey

Made geologic surveys in 32 States and Alaska.

Continued cooperative geologic work with 8 State organizations and with the Republic of Haiti, and through cooperation with governmental organizations and scientific institutions made on request special examinations relating to the geology of Hawaii, Iceland, Canada, Peru, the Philippine Islands, Argentina, Colombia, Bolivia, Java, the Pacific Islands, Mexico, New Zealand, and Cuba.

Made studies of ore deposits in 7 States and prepared or began to prepare 21 reports on ore deposits or mining districts.

Made field surveys and studies in 13 States with a view to determining the occurrence of oil and gas, prepared or began to prepare 32 reports on present or prospective oil and gas fields, and published maps showing oil and gas fields in Illinois, Oklahoma, Pennsylvania, and Wyoming.

Gave advice as to the adequacy of bids received for leases of oil and gas lands in the Osage Nation.

Continued the policy of undertaking intensive study of possible oil-bearing territory in advance of commercial development, carrying on such studies in the Black Hills, Colorado, and Wyoming.

Examined deposits of oil shale in 4 States.

Examined coal deposits in 3 States and prepared or began 5 reports on coal fields.

Cooperated with the Coast and Geodetic Survey and the Bureau of Soils in special investigations whose results may have very practical application.

Made comprehensive geologic, topographic, and hydrographic studies of portions of Colorado and San Juan rivers in Utah and Arizona, with the special object of determining the suitability of certain dam and reservoir sites.

Began the preparation of a geologic map of Arizona.

Completed studies of the radium-bearing carnotite ores and the tungsten deposits of the United States.

Cooperated with the Carnegie Institution in a study of earth movements in connection with earthquakes.

Cooperated with the United States Reclamation Service in geologic studies of dam and reservoir sites.

Made collections and examinations of fossils from 28 States for stratigraphic identification or correlation.

Continued the collection of statistics of mineral production and cooperated in this work with 18 States and the Bureau of the Census.

Issued special timely reports on the production of fuels.

Continued to obtain and supply information on foreign mineral reserves.

Continued the search for potash in natural salts in Texas, collecting and examining several hundred samples and finding workable percentages of potash in a number of them.

Made 1,720 quantitative analyses of rocks and minerals and over 2,200 qualitative tests of specimens submitted mainly by persons outside of the Survey.

Continued investigations of deep earth temperatures and of the porosity of oil and gas sands.

Continued studies of mineral deposits in Alaska.

Made geologic surveys covering 2,280 square miles and topographic surveys covering 505 square miles in Alaska.

Made topographic surveys in 21 States and Hawaii, partly in cooperation with other Government organizations and with 20 States and the Territory of Hawaii.

Mapped 12,057 square miles topographically and resurveyed 1,487 square miles.

Ran 3,236 miles of levels and established in connection with them 874 permanent bench marks.

Occupied 89 triangulation stations, of which 76 were permanently marked.

Ran 2,225 miles of primary traverse and set in connection therewith 483 permanent marks.

Prepared shaded relief maps of Alaska, California, Kentucky, and southwestern Arizona, also of several quadrangles and of the area adjacent to the Denver & Rio Grande Western Railroad.

Continued the compilation of the United States portion of the international map of the world, for which maps of 48 States have now been completed.

Prepared a map of China and adjacent regions for the Department of State in connection with the Conference on Limitation of Armament.

Made more than 11,000 measurements of stream flow in the United States and Hawaii, doing part of the work in cooperation with other Government organizations and with 31 States and Hawaii.

Made investigations of ground water in 10 States and Hawaii.

Analyzed 671 samples of surface and underground water.

Prepared monthly reports on the production of electricity and consumption of fuel by public-utility power plants and published maps of 14 States showing the location of power stations and transmission lines used in public service.

Continued investigations of the present and probable future use of surface and ground waters in connection with the classification of public lands.

Disposed of more than 25,000 cases referred to the Geological Survey for the preparation of reports thereon to be used in the administration of the public-land laws.

Made a net decrease of 459,341 acres in the area previously classified as coal land, a net increase of 268,359 acres in the area classified as phosphate land, and decreases of 3,914,988 acres in outstanding coal reserves, of 110,803 acres in outstanding petroleum reserves, and of 298,846 acres in outstanding phosphate reserves.

Acted on 7,638 applications for permit or lease rights under the mineral-lands leasing acts.

Defined the boundaries, in accordance with the known geologic structure, of five gas fields and one oil field in Wyoming and Montana.

Made plan and profile surveys of Colorado River in Utah and Arizona and of Klamath and Trinity rivers in California.

Made detailed studies of the possibility of developing power on rivers in Washington, Oregon, California, Idaho, Montana, Wyoming, Utah, and Colorado.

Made a net increase of 635,523 acres in power-site reserves.

Made field studies with respect to irrigability of lands under the enlarged and stock-raising homestead acts and the Nevada ground-water reclamation act in Colorado, Arizona, Utah, and Nevada.

Designated 382,320 acres in Nevada under the ground-water reclamation act. Included 1,160 acres in California in reservoir-site withdrawals.

Made net increases of 5,744 acres in public water reserves, of 3,989,427 acres in enlarged-homestead designations, and of 4,778,633 acres in stock-raising homestead designations.

Published 159 reports, containing 9,594 pages, and reprinted 7 reports.

Engraved and printed 70 new topographic maps and engraved wholly or in part 36 new topographic maps.

Photolithographed and printed 20 new State and other maps.

Printed 969,981 copies of new and reprinted maps.

Printed under contract for other branches of the Government lithographed maps, charts, etc., in editions amounting to 2,442,227 copies.

Distributed 590,284 copies of book publications and 739,310 of map publications, of which 8,253 folios and atlases and 594,217 maps were sold.

PUBLIC STATEMENTS BY THE DIRECTOR.

The Director has continued to show the bearing of scientific facts and conclusions upon public policy and matters of everyday interest by translating the results of the Survey's investigations into popular language for more general presentation than is possible in a Government report. The purpose of this work is to indicate the practical application of the scientific and engineering investigations carried on by the Survey. The Director has given the following addresses during the year:

Sept. 21. "The real value of oil." New York State Oil Producers' Association, Olean, N. Y.

Oct. 5. "The world distribution of minerals," General Staff College, Washington.

Oct. 19. "Some items in a prosperity program," American Mining Congress, Chicago.

Oct. 26. "Superpower," General Staff College, Washington.

Dec. 8. "A spendthrift industry," Coal Mining Institute of America, Pittsburgh, Pa.

Dec. 28. "Plain geology," American Society of Economic Geologists, Amherst, Mass.

Jan. 6. "Mineral resources in their international aspect," Conference of the Council on Foreign Relations, New York.

Jan. 23. "Work of the Interior Department," Conference of editors of business papers, Washington.

June 13. "Coal production and mine employment," Public Committee on Coal, New York.

June 26. "The broken coal year and how to mend it," National Conference of Social Work, Providence, R. I.

These addresses were printed in technical journals and proceedings of the societies. The following special articles were also prepared on request:

"Statistics the means to an end, not an end in themselves," Coal Age, July 14.

"Director Smith calls British terms 'a different experiment,'" Coal Review, Aug. 31.

"British coal problem becomes a market problem," Coal Age, Sept. 8.

"Present coal conditions in England," Black Diamond, Sept. 10.

"War problems in minerals—United States Geological Survey, 1914–1918," Engineering and Mining Journal, Dec. 3.

"Why should the consumer store coal?" Coal Review, Mar. 8.

"Wanted: More coal, fewer mines," The Nation's Business, June.

PUBLICATIONS.

The publications of the year comprised 159 book and map publications in the regular series, 92 maps, and numerous circulars, lists of publications and maps, advance statements on mineral production, and press bulletins. The total number of pages in the book and map publications was 9,594. Seven book publications and 198 maps were reprinted.

Brief notices of the publications in the regular series and of the new maps issued during the year are given in the following pages. These titles constitute the annual record of work accomplished—that is, completed to the extent of making the results available for use.

FORTY-SECOND ANNUAL REPORT of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30 1921. 108 pages, 1 plate.

A detailed account of the work of the Geological Survey during the fiscal year 1921. The Director sets forth the economy that is being attained through higher efficiency—the greater accomplishment for the same expenditure—and the limitations that act to prevent still higher efficiency such as inadequate office quarters, restriction on the selection of personnel, small salaries, and reduced appropriations for printing the report of investigations. One of the special investigations made during the year was the "superpower survey." (See Prof. Paper 123, below.) The Survey has continued to supervise topographic surveys in the Dominican and Haitian republics, in which the Marine Corps cooperated by furnishing a pilot and airplane for the use of a Survey engineer in taking aerial photographs to be used in making the topographic maps. The Director has continued his efforts to translate the results of the Survey's investigations into popular language in public addresses and magazine articles, to show the bearing of scientific facts and conclusions upon public policy and everyday questions.

PROFESSIONAL PAPER 123. A superpower system for the region between Boston and Washington, by W. S. Murray and others. 261 pages, 11 plates, 6 text figures.

Report of a "special investigation of the possible economy of fuel, labor and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries," authorized by Congress. The investigation was made by a staff of engineers under the administrative supervision of the Geological Survey. The engineering staff was assisted by constructive criticism from an advisory board consisting of men of vision and experience representing the railroads and industries. The annual net saving, if the energy required in this region in 1930 were supplied by a coordinated power system, such as is described in this report, instead of by uncoordinated systems, such as are now in use is estimated at \$429,000,000. As the total investment in generating and transmission facilities and motor equipment for the superpower system would be \$1,295,000,000, the annual return on the investment would be 33 per cent. Of the 36,000 miles of railroad in this region it is estimated that 19,000 miles can be profitably electrified, at an annual return on the investment of 14.2 per cent. The coal saved annually under the superpower system would amount to 50,000,000 tons. The system contemplates interconnection of existing plants and systems and construction of new steam-electric and hydroelectric plants at the most favorable locations. Within the territory covered by this investigation—the "super power zone"—is concentrated one-fourth of the population of the United States, and within it are operated, most of them independently, 31 electric utilities, 18 class 1 railroads, and 96,000 industrial plants. The superpower zone is the finishing shop of American industry.

PROFESSIONAL PAPER 128. Shorter contributions to general geology, 1920; David White, chief geologist. 1921. 146 pages, 22 plates, 16 text figures.

Contains seven papers by five authors, previously published separately. **PROFESSIONAL PAPER 129-B.** *Orithaulax*, a Tertiary guide fossil, by C. W. Cooke. 10 pages, 4 plates.

Describes the known species of a characteristic horizon marker found in the southeastern United States, the West Indies, and Panama.

PROFESSIONAL PAPER 129-C. Graphic and mechanical computation of thickness of strata and distance to a stratum, by J. B. Mertie, Jr. 16 pages, 3 plates 8 text figures.

Gives alignment charts and simplified methods for the solution of two problems that constantly confront the geologist who is studying stratigraphy and structure.

PROFESSIONAL PAPER 129-D. Stratigraphic sections in southwestern Utah and northwestern Arizona, by J. B. Reeside, jr., and Harvey Bassler. 27 pages, 5 plates, 1 text figure.

Describes features of general interest in the stratigraphy of a region concerning which very few detailed data are available in published literature. The region is in the Colorado River drainage basin, north of the Grand Canyon.

PROFESSIONAL PAPER 129-E. The Byram calcareous marl of Mississippi and its Foraminifera, papers by C. W. Cooke and J. A. Cushman. 46 pages, 15 plates.

Mr. Cooke describes the Byram marl, a lower Oligocene formation, and gives lists of fossils that have been found in it. Mr. Cushman describes 68 species and varieties of Foraminifera, all obtained from a few cubic centimeters of material.

PROFESSIONAL PAPER 129-F. The Foraminifera of the Mint Spring calcareous marl member of the Marianna limestone, by J. A. Cushman. 32 pages, 7 plates.

Describes 84 species of Foraminifera from a lower Oligocene series of beds in Mississippi.

PROFESSIONAL PAPER 129-G. The flora of the Woodbine sand at Arthurs Bluff, Tex., by E. W. Berry. 30 pages, 5 plates, 1 text figure.

Describes 43 species from a single locality, the study of which has led to complete and decisive conclusions in regard to the age and relations of the deposits.

PROFESSIONAL PAPER 129-H. Geology of the lower Gila region, Arizona, by C. P. Ross. 17 pages, 5 plates.

Sets forth the geologic information obtained during an investigation of desert watering places and routes of travel in a part of southwestern Arizona and gives a brief summary of the diverse mineral deposits in the region.

PROFESSIONAL PAPER 129-I. The flora of the Cheyenne sandstone of Kansas, by E. W. Berry. 27 pages, 16 plates.

Gives the results of a study of several collections which, though large, comprised only 23 species. Contains a historical summary of the application of the term "Dakota."

BULLETIN 679. The microscopic determination of the nonopaque minerals, by E. S. Larsen. 294 pages, 1 plate, 14 text figures.

Out of about 1,000 known mineral species comparatively few can be identified readily in thin sections. In this bulletin the author gives tables for the systematic determination of minerals from their optical constants, describes some methods for the rapid determination of optical constants, gives the results of measurements of the optical constants of more than 500 species for which data were not previously available, and presents statistics on the optical properties of minerals.

BULLETIN 714. Mineral resources of Alaska; report on progress of investigations in 1919, by A. H. Brooks and others. 259 pages, 7 plates, 2 text figures.

The sixteenth annual bulletin on investigations in Alaska. Contains 11 papers by 7 authors, previously published separately, also a list of recent Survey publications on Alaska.

BULLETIN 715. Contributions to economic geology (short papers and preliminary reports), 1920; Part I, Metals and nonmetals except fuels; F. L. Ransome, H. S. Gale, and E. F. Burchard, geologists in charge. 230 pages, 24 plates, 40 text figures.

Contains 12 papers on potash in Spain, Alsace, and Nebraska; manganese in Wyoming, Colorado, and Arkansas; cinnabar in Idaho; iron ore and phosphate rock in Montana; silver in Nevada and New Mexico; and salt in New Mexico, Texas, Oklahoma, and Kansas.

BULLETIN 716. Contributions to economic geology (short papers and preliminary reports), 1920; Part II, Mineral fuels; David White and M. R. Campbell, geologists in charge. 248 pages, 34 plates, 14 text figures, 1 insert.

Contains eight papers on oil or gas in Socorro County, N. Mex., the Upton-Thornton, Mule Creek, and Lance Creek fields, Wyoming, and the Dallas region, Texas, and on coal in eastern Idaho, in San Juan County, N. Mex., and near Harrison, W. Va.

- BULLETIN 722-A.** The Alaskan mining industry in 1920, by A. H. Brooks. 74, xiii pages.

The annual report on mining in Alaska. Although the industry as a whole suffered a serious depression in 1920, the value of the mineral output was nearly \$4,000,000 more than in 1919, chiefly because of the great increase in the production of copper. During 41 years of mining Alaska has produced minerals to the value of more than \$461,000,000, over half of which represents the output of the last decade. Of this sum \$320,000,000 is the value of the gold and \$127,000,000 that of the copper.

- BULLETIN 722-B.** Water-power investigations in southeastern Alaska, by G. H. Canfield. 41 pages, 1 plate.

The annual report on an investigation begun by the Geological Survey in cooperation with the Forest Service in 1915. Gives records of stream flow at 20 stations.

- BULLETIN 722-C.** Ore deposits of the Salmon River district, Portland Canal region, Alaska, by L. G. Westgate. 24 pages, 3 text figures.

Describes the Alaskan portion of a metal-bearing district that extends across the international boundary. Assays indicate the presence in this district of high-grade silver ores.

- BULLETIN 722-D.** Geology of the vicinity of Tuxedni Bay, Cook Inlet, Alaska, by F. H. Moffit. 7 pages, 1 plate.

Report on an area covering about 250 square miles on the west side of Cook Inlet. Discusses the possibilities of obtaining oil in this area and concludes that the conditions, so far as known, are unfavorable.

- BULLETIN 722-E.** Gold lodes in the upper Kuskokwim region, Alaska, by G. C. Martin. 13 pages, 1 plate, 2 text figures.

Describes a comparatively little known region to which attention has recently been attracted by the discovery of high-grade ores there. The reported assays of the ores range from \$30 to \$65 to the ton.

- BULLETIN 722-F.** Metalliferous lodes in southern Seward Peninsula, Alaska, by S. H. Cathcart. 113 pages, 14 text figures.

Lode prospecting in Seward Peninsula began soon after placers were discovered and has been continued for 20 years, but only a few mines have ever been productive, and none are producing at present. This paper gives the results of a study that was intended to aid the prospector by ascertaining the geologic conditions under which the metalliferous lodes were formed.

- BULLETIN 725-A.** Deposits of chromite in California, Oregon, Washington, and Montana, by J. S. Diller, L. G. Westgate, and J. T. Pardee. 91 pages, 5 plates, 23 text figures.

- BULLETIN 725-B.** Chrome ores in Pennsylvania, Maryland, and North Carolina; papers by E. B. Knopf and J. V. Lewis. 59 pages, 1 plate, 3 text figures.

During the World War it was demonstrated that the United States has reserve deposits of chromium adequate to supply a war demand for several years. Now that the war is over the country is conserving its domestic supplies by employing higher-grade and cheaper ore from foreign countries. It is desirable, however, to record the facts concerning our own deposits, and these pamphlets contain several papers on chromite in the States named.

- BULLETIN 725-C.** Deposits of manganese ore in Montana, Utah, Oregon, and Washington, by J. T. Pardee. 110 pages, 4 plates, 11 text figures.

Another paper in the series recording the results of investigations of domestic manganese deposits during the World War.

- BULLETIN 725-D.** Contact-metamorphic tungsten deposits of the United States, by F. L. Hess and E. S. Larsen. 70 pages, 4 plates, 10 text figures.

Contact-metamorphic tungsten deposits have been found at 23 localities in the western United States, nearly all in California and Nevada. The first one known was discovered in 1908, but only prospecting and development work was done until 1915. The high prices paid for tungsten during the war stimulated active work at this deposit and a search for others. This bulletin describes the deposits in detail and sets forth the general geology, with a full treatment of the process of contact metamorphism.

BULLETIN 725-E. Manganese deposits near Bromide, Okla., by D. F. Hewett. 19 pages, 4 text figures.

Describes deposits to which attention was called during the period of prospective shortage of manganese ore in 1917. The deposits are small and can not yield much high-grade ore, but their geologic relations and the minerals they contain are so uncommon that a description of them is of scientific interest.

BULLETIN 725-F. Pyrite at the Halle mine, Kershaw, S. C., with a note on pyritization at the Brewer mine, near Jefferson, by F. C. Schrader.

During the World War the Geological Survey examined and estimated the ore reserves of the United States with a view to ascertaining the possibility of supplying the increased demand for sulphuric acid. One of the most interesting and promising of recent developments in this connection is the conversion of the Halle gold mine, at Kershaw, S. C., into a pyrite mine, described in detail in this paper.

BULLETIN 725-G. The Taylor Creek tin deposits, New Mexico, by J. M. Hill. 13 pages, 1 text figure.

Describes deposits which, though small and not very rich, are of interest in view of the scarcity of tin deposits in the United States.

BULLETIN 725-H. Ore deposits of Cedar Mountain, Mineral County, Nev., by Adolph Knopf. 22 pages, 5 text figures.

Describes the geology and ore deposits at two small mining camps that center around two mines, one of which produces silver-lead and the other gold.

BULLETIN 725-I. The Round Mountain district, Nevada, by H. G. Ferguson. 24 pages, 6 text figures.

The Round Mountain district has produced mainly gold and silver, but a little tungsten was mined there during the World War. This paper describes the geology and ore deposits.

BULLETIN 725-J. Ore deposits of the Sierrita Mountains, Pima County, Ariz., by F. L. Ransome. 35 pages, 4 plates, 4 text figures.

Describes deposits of copper, lead, zinc, and silver ores on both sides of the Sierrita Mountains, in southern Arizona. Copper is the chief item in the metal output, and as much as 6,080,000 pounds has been produced in a single year. The deposits are of contact-metamorphic origin.

BULLETIN 726-B. Geology of the Cement oil field, Caddo County, Okla., by Frank Reeves. Prepared in cooperation with the Office of Indian Affairs. 89 pages, 7 plates, 4 text figures.

Discusses an area covering eight townships in southwestern Oklahoma. The pronounced anticline at Cement and other folds near by suggested that the area of tilted strata bordering the mountains should contain local anticlines favorable for the accumulation of oil and gas. About half of the area studied is owned by the Indians, and as many tracts of Indian lands are leased to oil companies annually, knowledge of the true value of oil rights is especially desirable.

BULLETIN 726-C. Oil prospects in Washington County, Utah, by Harvey Bassler and J. B. Reeside, Jr. 23 pages, 4 text figures.

Oil was discovered near Virgin City, Utah, in 1907, and for a short time exploration was active, but there was no market for the oil at that time and nothing more was done in this field till 1918. The authors of this paper, who made a reconnaissance examination of the field in 1919, conclude that the present field is of value for supplying local demand, and that possibly thicker oil-bearing beds may be found elsewhere in the region.

BULLETIN 726-D. Lignite in the western part of the Fort Berthold Indian Reservation south of Missouri River, N. Dak., by C. M. Bauer and F. A. Herald. 64 pages, 17 plates, 3 text figures.

In the northern Great Plains wood for fuel is practically lacking, and the lignite of the region is therefore of particular importance in the development of its commerce and industry. This paper describes the lignite deposits of an area in west-central North Dakota about 65 miles northwest of Bismarck. Analyses show that in heating value the lignite of this region at \$5 a ton is equivalent to Pittsburgh bituminous coal at \$11.36 a ton.

- BULLETIN 726-E.** Geologic structure of parts of New Mexico, by N. H. Darton. 110 pages, 21 plates, 33 text figures.
 Gives the available information concerning the structural features of New Mexico as a guide to the geologist in search of new oil fields. New Mexico is not yet producing oil in notable amounts, but in many places the structural conditions are favorable to the accumulation of oil and gas if they are present in the rocks.
- BULLETIN 726-F.** Geologic structure and oil and gas prospects of a part of Jefferson County, Okla., by H. M. Robinson. 26 pages, 2 plates, 1 text figure.
 Describes an area of about 175 square miles, in which the general structure is regarded as favorable, though the area is not very close to any commercially productive oil and gas field.
- BULLETIN 728-G.** The Lacasa area, Ranger district, north-central Texas, by C. S. Ross. 12 pages, 2 plates, 3 text figures.
 The geologic structure of an area in Stephens County, Tex., is described and mapped, and the tracts that are considered favorable or unfavorable for oil or gas accumulation are pointed out.
- BULLETIN 730-A.** Penepains of the Front Range and Rocky Mountain National Park, Colo., by W. T. Lee. 17 pages, 8 plates, 3 text figures.
 The first of a new series, "Contributions to the geography of the United States," to be published annually, first in the form of separate chapters. Points out the probable correlation of some of the major surface features in the Rocky Mountain National Park with similar features in neighboring regions.
- BULLETIN 730-B.** Erosion and sedimentation in the Papago country, Arizona, with a sketch of the geology, by Kirk Bryan. 72 pages, 5 plates, 22 text figures.
 The country inhabited by the Papago Indians, a tribe of nomadic farmers, is an area of 13,000 square miles in southwestern Arizona, between Gila River and the Mexican boundary. It is in large part a true desert, though the climatic conditions have produced large cacti, trees, and woody shrubs that give it a deceiving verdure. This paper describes the land forms in this peculiar region and discusses the processes that have been active in the production of the desert landscape. It contains a glossary of technical terms.
- BULLETIN 735-A.** The Candelaria silver district, Nevada, by Adolph Knopf. 22 pages, 2 text figures.
 Candelaria, an old silver-mining camp in western Nevada, has produced \$20,000,000, mainly about 40 years ago. The bonanza ore has long been exhausted, and the attempt now being made to revive the camp is based on the belief that there is left a considerable amount of ore of moderate grade from which a profit may be won by modern methods of mining and metallurgy. This report shows that the future prosperity of the district is not to be sought by exploring in depth but must be won from the territory lying above the deepest levels yet worked.
- BULLETIN 735-B.** Colemanite in Clark County, Nev., by L. F. Noble. 17 pages, 3 plates, 2 text figures.
 Describes some recently discovered deposits of colemanite, a mineral that yields borax, in the Muddy Mountains. The deposits are fairly extensive, and one of them is of remarkable continuity and regularity and appears to afford unusual facilities for efficient and economical mining.
- BULLETIN 735-C.** Bonanza ores of the Comstock lode, Virginia City, Nev., by E. S. Bastin. 25 pages, 9 text figures.
 Gives results of a microscopic study of specimens obtained at depths ranging from a few hundred to 2,900 feet. This study showed that in ores from depths greater than 500 feet, including the bulk of the bonanza ores of the lode, the silver is essentially all in primary minerals and that gold is primary in all the ores. These results offer encouragement for deep development, though ore bodies comparable in size and richness to the great bonanzas of the past are not to be expected.
- BULLETIN 730-A.** The structure of the Madill-Denison area, Oklahoma and Texas, with notes on oil and gas development, by O. B. Hopkins, Sidney Powers, and H. M. Robinson. 33 pages, 6 plates.
 Describes the geologic structure of an area in Marshall County, Okla., and Grayson County, Tex., which includes the Madill oil field and the Enos gas field. Gives suggestions for prospecting.

WATER-SUPPLY PAPER 450. Contributions to the hydrology of the United States, 1919; N. C. Grover, chief hydraulic engineer. 1921. 86 pages, 11 plates, 5 text figures, 1 insert.

Contains papers on the geology and water resources of a part of the San Carlos Indian Reservation, Ariz., and on ground water in Lanfair Valley, Calif., and in Pahrump, Mesquite, and Ivanpah valleys, Nev.-Calif.

WATER-SUPPLY PAPER 459. Surface water supply of the United States, 1917; Part IX, Colorado River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, C. C. Jacob, and C. E. Ellsworth, district engineers. 192, xxxiii pages, 2 plates.

WATER-SUPPLY PAPER 460. Surface water supply of the United States, 1917; Part X, The Great Basin; N. C. Grover, chief hydraulic engineer; C. C. Jacob, H. D. McGlashan, F. F. Henshaw, G. C. Baldwin, and Robert Follansbee, district engineers. 277, xl pages, 2 plates.

WATER-SUPPLY PAPER 471. Surface water supply of the United States, 1918; Part I, North Atlantic slope drainage basins; N. C. Grover, chief hydraulic engineer; C. H. Pierce, C. C. Covert, and G. C. Stevens, district engineers. Prepared in cooperation with the States of Maine, Vermont, Massachusetts, and New York. 220 pages, 2 plates, 1 text figure.

WATER-SUPPLY PAPER 475. Surface water supply of the United States, 1918; Part V, Hudson Bay and upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. G. Hoyt, district engineer. Prepared in cooperation with the States of Minnesota, Wisconsin, Iowa, and Illinois. 183 pages, 2 plates.

WATER-SUPPLY PAPER 476. Surface water supply of the United States, 1918; Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb and Robert Follansbee, district engineers. Prepared in cooperation with the States of Colorado, Montana, and Wyoming. 310 pages, 2 plates.

WATER-SUPPLY PAPER 477. Surface water supply of the United States, 1918; Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee and R. C. Rice, district engineers. 38 pages, 2 plates.

Six of the annual reports on stream gaging.

WATER-SUPPLY PAPER 487. The Arkansas River flood of June 3-5, 1921, by Robert Follansbee and E. E. Jones. 44 pages, 6 plates, 1 text figure.

Report on the severest flood that has occurred in the Arkansas River valley since its settlement. This flood was due mainly to heavy rainfall and in part to the breaking of a reservoir dam. The loss of life was heavy, and the total property losses are estimated at more than \$19,000,000. This report describes the cause and effects of the flood and gives notes on previous floods in this valley.

WATER-SUPPLY PAPER 490-B. Routes to desert watering places in the Mohave Desert region, California, by D. G. Thompson. Prepared in cooperation with the Department of Engineering of the State of California. 269 pages, 18 plates, 3 text figures.

The second in the series of "desert guides" for the southwestern region of the United States. Contains five large maps showing roads and watering places, a general description of the region, suggestions for desert travel, and 232 pages of detailed road logs.

WATER-SUPPLY PAPER 500-B. Ground water for irrigation near Gage, Ellis County, Okla., by D. G. Thompson. 23 pages, 1 plate, 3 text figures.

Gives the results of a field examination to determine the possibility of obtaining water for use in irrigation from deep wells. The average annual precipitation in the Gage region is barely sufficient for farming. In 1918 a large flow of water was struck in a well being drilled for oil near Gage, and this suggested that other sources might be available, but the author concludes that the farmers can find relief from drought not so much by irrigation as by a careful study of the crops and farming methods best adapted to the climate.

WATER-SUPPLY PAPER 500-C. Some characteristics of run-off in the Rocky Mountain region, by Robert Follansbee. 17 pages, 10 text figures.

For the last nine years the Geological Survey has made a special study of the run-off of the streams that flow from the high mountain areas of Colorado and Wyoming, which furnish water for irrigating millions of acres of land, for developing electrical energy at many water-power plants, and, in their lower courses, for transportation. During this period 40 or

- more gaging stations in the mountains, above practically all diversions have been maintained for long periods, and the records thus obtained, together with studies of the topography, form the basis of this report.
- MINERAL RESOURCES OF THE UNITED STATES, 1918, Part I, Metals;** G. F. Loughlin, geologist in charge. 1,095 pages, 9 plates, 20 text figures, 1 insert.
- The chapters of this volume were published at different dates between May 8, 1919, and August 15, 1921. The grand total value of mineral products in 1918 was about \$5,541,000,000, an increase of 11 per cent over the value in 1917.
- MINERAL RESOURCES OF THE UNITED STATES, 1918, Part II, Nonmetals;** R. W. Stone, geologist in charge. 1,557 pages, 16 plates, 135 text figures, 3 inserts.
- MINERAL RESOURCES OF THE UNITED STATES, 1919.** 30 advance chapters.
- MINERAL RESOURCES OF THE UNITED STATES, 1920.** 59 advance chapters.
- MINERAL RESOURCES OF THE UNITED STATES, 1921.** 11 advance chapters.
- GEOLOGIC FOLIO 213.** New Athens-Okawville, Ill., by E. W. Shaw. 12 pages of folio text, 4 maps, 6 text figures.

The New Athens and Okawville quadrangles cover 468 square miles in southwestern Illinois, a short distance southeast of St. Louis, and lie in the great area of rolling country that has been called the Glaciated Plains. The area is in the eastern interior coal basin and yields bituminous coals of excellent quality. The hard rocks are of Carboniferous age and are nearly everywhere overlain by unconsolidated Quaternary drift, loess, and alluvium. This folio describes the general features of the Glaciated Plains province and gives a detailed account of the geology of the two quadrangles.

- WORLD ATLAS OF COMMERCIAL GEOLOGY, Part II, Water power of the world.** 30 pages, 10 maps.

The potential water power of the world is estimated at 439 million horsepower at low water, of which 62 million horsepower is in North America and 28 million in the United States. Africa is richest in undeveloped water power, with 190 million horsepower; Asia has 71 million horsepower, South America 54 million horsepower, and Europe 45 million horsepower. About 40 per cent of the developed water power of the world is in the United States, where water wheels having a capacity of 9,243,000 horsepower are installed. The leading States are New York, with 1,300,000 horsepower, and California, with 1,111,000 horsepower. In Europe France leads with 1,400,000 horsepower, Norway has 1,350,000 horsepower, Sweden 1,200,000 horsepower, and Switzerland 1,070,000 horsepower. The largest water-power development in the world is at Niagara Falls, where the plants now in operation have a capacity of 870,000 horsepower, of which 385,000 horsepower is on the United States side. The capacity on both sides is now being increased. This publication summarizes all present knowledge on the subject indicated, mentions some of the world's largest water-power developments, and gives estimates by countries and by continents of the developed and undeveloped water power.

- TOPOGRAPHIC AND OTHER MAPS** as indicated below. (The maps marked * were also published with a green overprint showing woodland areas.)

Alaska.

- Kotsina-Kuskulana district:** Scale, 1 inch=1 mile; contour interval, 100 feet. Latitude of center of area, $61^{\circ} 39'$; longitude of center of area, $143^{\circ} 55'$.
- Map of an area at the southwest base of the Wrangell Mountains, a rough, mountainous area that has a relief of more than 6,000 feet, crossed by the valleys of Kotsina and Kuskulana rivers, both of which flow in braided channels on alluvial plains. The principal mountain summits stand at altitudes of more than 6,500 feet, and several reach 7,500 feet or more.

California.

- Bonita Ranch:** Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $32^{\circ} 30'$ to 37° ; longitude, $120^{\circ} 7'$ to $120^{\circ} 15'$.
- Map of part of Madera County, in the Great Valley of California, plain sloping gently westward, across which extends the valley of Fresno River, which as mapped normally carries no surface water.

*Cape San Martin: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 35° 45' to 36°; longitude, 121° 15' to 121° 30'.

Map of parts of Monterey and San Luis Obispo counties, showing part of the ragged coast line and the Santa Lucia Range, which rises steeply from the shore to more than 3,500 feet above the sea. Northeast of the mountains is lower country, in which Nacimiento River flows. The depths of the sea down to about 1,000 feet are indicated by contours.

Carbona: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 37° 30' to 37° 45'; longitude, 121° 15' to 121° 30'.

Map of parts of San Joaquin and Stanislaus counties, lying about half in San Joaquin Valley and half on the northeastern slope of the Coast Ranges, some peaks of which reach altitudes of more than 3,000 feet. There are no large perennial streams except San Joaquin River, which crosses the areas in a highly meandering course.

Charleston School: Scale, 2 inches=1 mile; contour interval, 5 and 25 feet, changing on the 400-foot contour. Latitude, 36° 52' 30'' to 37°; longitude, 120° 45' to 120° 52' 30''.

Map of a part of Merced County, lying in San Joaquin Valley and the foothills of the Diablo Range. The valley portion of the area slopes gently northeastward and is crossed by two main irrigation canals. The foothills portion has a relief of about 1,000 feet.

Delta Ranch: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, 37° to 37° 7' 30''; longitude, 120° 37' 30'' to 120° 45'.

Map of part of Merced County showing San Joaquin River and the broad irrigated lowland adjacent to it. The difference in elevation between the highest and lowest points in the area is less than 25 feet.

*Gonzales: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° 30' to 36° 45'; longitude, 121° 15' to 121° 30'.

Map of parts of San Benito and Monterey counties, an area occupied in large part by the Gabilan Range, many of whose peaks rise more than 3,000 feet above sea level.

Gregg: Scale, 2 inches=1 mile; contour interval, 5 feet. Latitude, 36° 52' 30'' to 37°; longitude, 119° 52' 30'' to 120°.

Map of a part of Madera County occupied by a gently sloping plain which is rather rough on a small scale but which has a relief of only about 100 feet. This slope appears to be formed of coalescent debris fans from the foothills of the Sierra Nevada.

*Hollister: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° 45' to 37°; longitude, 121° 15' to 121° 30'.

Map of parts of San Benito, Monterey, and Santa Clara counties, including the southern parts of San Benito and Santa Clara valleys and the mountains of the Diablo and Gabilan ranges. The absence of streams of any considerable size on the floors of the two large valleys is notable.

Howard Ranch: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 and 25 feet. Latitude, 37° 7' 30'' to 37° 15'; longitude, 121° to 121° 7' 30''.

Map of parts of Merced and Stanislaus counties, near the western border of the Great Valley of California. In its eastern part the area is a plain that slopes gently eastward. In its western part there are hills that rise abruptly from the plain to elevations of nearly 1,000 feet.

*Jamesburg: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° 15' to 36° 30'; longitude, 121° 30' to 121° 45'.

Map of part of Monterey County, southeast of the city of Monterey, a mountainous region several of whose peaks in the Santa Lucia Range rise to elevations of more than 4,700 feet. The lowest points in the area stand less than 250 feet above the sea.

Kentucky Well: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, 36° 52' 30'' to 37°; longitude, 120° 15' to 120° 22' 30''.

Map of a part of Madera County that lies in the gently westward-sloping plain of central California, a region where the greatest range in elevation is only 45 feet.

Lanes Bridge: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 and 25 feet. Latitude, 36° 52' 30'' to 37°; longitude, 119° 45' to 119° 52' 30''.

Map of parts of Madera and Fresno counties, in the Great Valley of California, north of Fresno. San Joaquin River, in the southeastern part, flows in a steep-sided trench a mile or more wide that has been carved in the dissected plain. Rising abruptly above this plain is a conspicuous highland, Little Table Mountain, more than 800 feet above the sea.

Los Banos: Scale, 1 inch= $\frac{1}{4}$ mile; contour interval, 5 feet. Latitude, 37° to $37^{\circ} 7' 30''$; longitude, $120^{\circ} 45'$ to $120^{\circ} 52' 30''$.

Map of part of Merced County, in the broad, nearly flat floor of San Joaquin Valley. Shows a great number of canals and irrigation ditches.

Madera: Scale, 1 inch= $\frac{1}{4}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 52' 30''$ to 37° ; longitude, 120° to $120^{\circ} 7' 30''$.

Map of part of Madera County, showing the city of Madera and the nearly flat plain on part of which the city has been built. Fresno River as mapped has a sandy channel without surface water.

***Nipomo:** Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 35° to $35^{\circ} 15'$; longitude, $120^{\circ} 15'$ to $120^{\circ} 30'$.

Map of parts of San Luis Obispo and Santa Barbara counties, in the Santa Lucia and San Rafael mountains, some of whose peaks stand more than 3,000 feet above the sea.

Ortigalita: Scale, 1 inch= $\frac{1}{4}$ mile; contour interval, 25 feet. Latitude, $36^{\circ} 52' 30''$ to 37° ; longitude, $120^{\circ} 52' 30''$ to 121° .

Map of part of Merced County in the belt of foothills between the Diablo Range and San Joaquin Valley. The surface of the area is considerably diversified, comprising moderately rugged hilly country rising 1,100 feet above sea level, a nearly level-floored basin at 800 feet, and a little of San Joaquin Valley below 200 feet.

Oxalis: Scale, 2 inches=1 mile; contour interval, 5 feet. Latitude, $36^{\circ} 52' 30''$ to 37° ; longitude, $120^{\circ} 30'$ to $120^{\circ} 37' 30''$.

Map of part of Fresno County in San Joaquin Valley. The whole area is very flat, having a relief of only 40 feet, exclusive of the shallow trench of San Joaquin River.

Piru: Scale, 1 inch=1 mile; contour interval, 100 feet. Latitude, $34^{\circ} 15'$ to $34^{\circ} 30'$; longitude, $118^{\circ} 45'$ to 119° .

Map of a part of Ventura County. The broad, normally dry valley bottom of Santa Clara River crosses the area and is flanked by the mountains of the Santa Barbara National Forest and by Oak Ridge.

***Quien Sabe:** Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, $36^{\circ} 45'$ to 37° ; longitude, 121° to $121^{\circ} 15'$.

Map of parts of Merced, San Benito, and Santa Clara counties, in the Diablo Range, whose highest peaks rise more than 3,500 feet above the sea. Several lowlands like Quien Sabe and Los Banos valleys occur in the midst of the highlands.

San Luis Creek: Scale, 1 inch= $\frac{1}{4}$ mile; contour interval, 5 and 25 feet. Latitude, 37° to $37^{\circ} 7' 30''$; longitude, 121° to $121^{\circ} 7' 30''$.

Map of part of Merced County, near the west border of the Great Valley of California. The northeastern part of the area is a low plain, west of which the country is hilly, and some of the higher points stand more than 1,700 feet above the sea.

Santa Rita Bridge: Scale, 1 inch= $\frac{1}{4}$ mile; contour interval, 5 feet. Latitude, 37° to $37^{\circ} 7' 30''$; longitude, $120^{\circ} 30'$ to $120^{\circ} 37' 30''$.

Map of parts of Merced and Madera counties, a plain traversed by San Joaquin River and its tributaries and slopes. Numerous irrigating ditches intersect the rich agricultural lands in all directions.

Triunfo Pass: Scale, 1 inch=1 mile; contour interval, 100 feet. Latitude, 34° to $34^{\circ} 15'$; longitude, $118^{\circ} 45'$ to 119° .

Map of parts of Ventura and Los Angeles counties, including the coast line, the Santa Monica Mountains, which rise to elevations of more than 2,500 feet and stand about 5 miles inland, and lowlands interspersed with other groups of hills.

Volta: Scale, 1 inch= $\frac{1}{4}$ mile; contour interval, 5 and 25 feet. Latitude, 37° to $37^{\circ} 7' 30''$; longitude, $120^{\circ} 52' 30''$ to 121° .

Map of part of Merced County showing the lowland of San Joaquin Valley and the foothills on the west. The area contains no perennial streams but is intricately traversed by canals and irrigation ditches.

Connecticut.

[See Massachusetts, etc.]

Delaware, District of Columbia, and Maryland.

Electric generating stations and transmission lines used in the public service in the District of Columbia and the States of Delaware and Maryland in 1919. Scale, 1 inch=8 miles.

The hydroelectric generating stations, the fuel-consuming generating stations, the stations combining these two sources of power, the substations, the switching stations, and the primary transmission lines are shown by distinctive symbols printed in red on the United States Geological Survey's base map of the area.

Georgia.

*Brooklet: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, $32^{\circ} 15'$ to $32^{\circ} 30'$; longitude, $81^{\circ} 30'$ to $81^{\circ} 45'$.

Map of parts of Bulloch and Effingham counties, in the Atlantic Coastal Plain. The upland in the eastern part of the area is a nearly flat plain, on which there are a great number of small, irregularly distributed marshy tracts. West of this plain is a dissected upland whose highest points stand at elevations of more than 320 feet. The largest stream, Edisto River, has cut down the floor of its valley to an elevation of about 50 feet above the sea.

*Hephzibah: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $33^{\circ} 15'$ to $33^{\circ} 30'$; longitude, 82° to $82^{\circ} 15'$.

Map of parts of Richmond, Columbia, and Burke counties, including the western part of the city of Augusta. The region is a rolling, hilly country and has moderately broad, flat uplands, many of which stand 400 to 500 feet above the sea.

Georgia and South Carolina.

*Augusta: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $33^{\circ} 15'$ to $33^{\circ} 30'$; longitude, $81^{\circ} 45'$ to 82° .

Map of parts of Aiken County, S. C., and Richmond and Burke counties, Ga. The most prominent topographic feature is the broad, swampy flood plain through which Savannah River flows and on which, where it has been improved by levees and drainage ditches, the city of Augusta stands.

*Clarks Hill: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $33^{\circ} 30'$ to $33^{\circ} 45'$; longitude, 82° to $82^{\circ} 15'$.

Map of parts of Edgefield, McCormick, and Aiken counties, S. C., and Columbia, Lincoln, and Richmond counties, Ga., a much dissected, hilly region that forms part of the Piedmont province. Savannah River, which forms the boundary between the two States, flows diagonally across the area in a narrow-floored valley and is ponded by dams constructed to generate power.

Idaho.

*Custer: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 44° to $44^{\circ} 30'$; longitude, $114^{\circ} 30'$ to 115° .

Map of part of Custer County, a mountainous region, some of whose peaks rise to elevations of more than 11,000 feet. Salmon River, the largest stream in the area, flows at right angles to the general trend of the mountains, in a narrow canyon whose floor is several thousand feet below the near-by summits.

Illinois.

[See also Kentucky and Illinois.]

New Athens. Geologic map from Folio 213. (See p. 10.)

Oil and gas fields of the State of Illinois. Scale, 1 inch=8 miles.

Map prepared in cooperation with the Illinois Geological Survey, on the United States Geological Survey's base map of Illinois. The productive oil and gas fields, the main oil pipe lines, and the oil refineries are shown by distinctive colors and symbols.

Wauville. Geologic map from Folio 213. (See p. 10.)

Indiana.

Electric generating stations and transmission lines used in the public service in the State of Indiana in 1921. Scale 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

Kansas.

State map: Scale, 1 inch=8 miles.

Base map of the State of Kansas in one color (black). It shows county and township boundaries, towns and most of even the smaller settlements, railroads, rivers, and many of the smaller streams and water features. This map forms part of the so-called "millionth map," though it is published on twice the scale adopted for that series and does not have contours and certain other features that will be shown on the final map.

Kentucky.

*Brownsville: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 37° 15' to 37° 30'; longitude, 86° 15' to 86° 30'.

Map of parts of Edmonson, Warren, and Butler counties, including the northern part of the city of Bowling Green. The area is a much dissected low plateau traversed by Green and Barren rivers, both rather large streams, which flow in narrow-floored valleys.

Kentucky and Illinois.

*Golconda: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 37° 15' to 37° 30'; longitude, 88° 15' to 88° 30'.

Map of parts of Hardin and Pope counties, Ill., and Crittenden and Livingston counties, Ky. A dissected low plateau traversed by Ohio River and its tributaries. The highest point in the area is about 750 feet above the sea.

Louisiana.

State map: Scale, 1 inch=8 miles.

Similar to base map of Kansas. (See above.)

Louisiana and Mississippi.

*Natchez: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 31° 30' to 31° 45'; longitude, 91° 15' to 91° 30'.

Map of parts of Concordia and Tensas parishes, La., and Adams and Jefferson counties, Miss. The eastern half of the area is a low dissected plateau that stands 200 to 400 feet above the sea. The western half is part of the flood plain of the Mississippi, across which the river flows in large loops. The city of Natchez has been built on the upland at a point where the river flows directly against the bluffs.

Maine.

Electric generating stations and transmission lines used in the public service in the State of Maine in 1919. Scale, 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

State map. Scale, 1 inch=8 miles.

Similar to base map of Kansas. (See above.)

Maryland.

[See Delaware, etc.; West Virginia and Maryland.]

Maryland and West Virginia.

[See also West Virginia and Maryland.]

*Elk Garden: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 39° 15' to 39° 30'; longitude, 79° 15' to 79° 30'.

Map of parts of Garrett and Allegany counties, Md., and Mineral and Grant counties, W. Va., a region traversed by narrow parallel ridges that are followed successively by the Allegheny Front and the plateau that crossed by the North Branch of Potomac River.

*Keyser: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude 39° 15' to 39° 30'; longitude, 78° 45' to 79°.

Map of parts of Allegany County, Md., and Mineral and Hampshire counties, W. Va. The geologic structure of the area has given rise to parallel ridges and valleys, across which the streams cut here and there in narrow gorges.

Massachusetts, Rhode Island, and Connecticut.

Electric generating stations and transmission lines used in the public service in 1919. Scale, 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

Michigan.

*Burt: Scale, 1 inch=1 mile; contour interval, 5 feet. Latitude, 43° to 43° 15'; longitude, 83° 45' to 84°.

Map of parts of Genesee, Shiawassee, and Saginaw counties, a northward-sloping plain slightly dissected by Flint River and its tributaries, which flow in rather narrow trenches, few of them cut more than 40 feet below the near-by upland.

*Rives Junction: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 15' to 42° 30'; longitude, 84° 15' to 84° 30'.

Map of parts of Jackson and Ingham counties, including the northern part of the city of Jackson and the lowland country to the north. Numerous morainic hills, lakes, marshes, and streams bear witness to the former occupation of the area by continental glaciers.

*Springport: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 15' to 42° 30'; longitude, 84° 30' to 84° 45'.

Map of parts of Jackson, Eaton, Ingham, and Calhoun counties, a morainic region which is characterized by innumerable small knobs and depressions and in which the streams flow in irregular, straggling courses, in places avoiding lowlands that appear to mark former drainage courses.

*Stockbridge: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 15' to 42° 30'; longitude, 84° to 84° 15'.

Map of an area in Ingham, Jackson, Livingston, and Washtenaw counties, whose surface is formed almost wholly of glacial deposits. The surface as a whole is poorly drained, many of the hollows being occupied by ponds or small lakes, and nearly all the low-lying flat lands are swampy.

Mississippi.

[See also Louisiana and Mississippi.]

*Booneville: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 34° 30' to 34° 45'; longitude, 88° 30' to 88° 45'.

Map of parts of Prentiss, Tippah, Union, and Lee counties. Throughout the eastern part of the area the summits of the upland stand from 400 to 500 feet above sea, but in the western part the Tippah Hills rise to elevations of nearly 800 feet.

Forest: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 32° 15' to 32° 30'; longitude, 89° 15' to 89° 30'.

Map of parts of Scott and Newton counties, a region of low relief, the highest points in which rise to about 600 feet above the sea.

Missouri.

Sarcoile: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 37° to 37° 15'; longitude, 94° to 94° 15'.

Map of parts of Jasper and Newton counties, just east of the Joplin lead and zinc district. The region is a dissected plain, most of whose upland surface stands between 1,100 and 1,200 feet above the sea.

Stotts City: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 37° to 37° 15'; longitude, 93° 45' to 94°.

Map of part of Lawrence County, a rolling plateau traversed by Spring River, whose steep-sided valley floor, one-half to three-quarters of a mile wide, is trenched below the upland.

Nebraska.

State map: Scale, 1 inch=8 miles.

Similar to base map of Kansas. (See p. 14.)

New Hampshire.

- * Suncook: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° to 43° 15'; longitude, 71° 15' to 71° 30'.

Map of parts of Merrimack and Rockingham counties lying just east of Concord and including the northern part of Manchester. The area is hilly and is traversed by Merrimack River. There are a number of lakes and ponds, which, together with many of the other features, have apparently been formed by glaciation.

New Hampshire and Vermont.

Electric generating stations and transmission lines used in the public service in the States of New Hampshire and Vermont in 1919. Scale, 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

New Jersey.

Electric generating stations and transmission lines used in the public service in the State of New Jersey in 1920. Scale, 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

New York.

- * Cranberry Lake: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 44° to 44° 15'; Longitude, 74° 45' to 75°.

Map of parts of St. Lawrence, Hamilton, and Herkimer counties, on the western flanks of the Adirondacks, a region of glaciated knobs and hills, some of which rise to elevations of more than 2,000 feet, and lowlands, many of which are occupied by lakes.

Electric generating stations and transmission lines used in the public service in the State of New York in 1919. Scale, 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

- * Nicholville: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 44° 30' to 44° 45'; longitude, 74° 30' to 74° 45'.

Map of parts of Franklin and St. Lawrence counties, on the northwestern flanks of the Adirondacks, a region characterized by knobby hills and irregularly distributed small lakes and marshes, which, together with other features, indicate the ancient glaciation of the area.

Oklahoma.

Oil and gas fields of the State of Oklahoma: Scale, 1 inch=12 miles.

Similar to map of Illinois. (See p. 13.)

State map: Scale, 1 inch=8 miles.

Similar to base map of Kansas. (See p. 14.)

Oregon.

- * Cottage Grove: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 43° 45' to 44°; longitude, 123° to 123° 15'.

Map of parts of Lane and Douglas counties. The eastern part of the quadrangle is occupied by the lowland in which the Coast Fork of Willamette River flows, but the western part is hilly, some of the hills rising to elevations of more than 1,600 feet.

- * Lebanon: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 44° 30' to 44° 45'; longitude, 122° 45' to 123°. (Part of quadrangle.)

Map of part of Linn County showing mainly South Santiam River and the lowlands adjacent to it, which form part of the famous fruit and agricultural land of the Willamette Valley.

*Waldport: Scale 1 inch=1 mile; contour interval, 50 feet. Latitude, 44° 15' to 44° 30'; longitude, 124° to 124° 15'.

Map of parts of Lincoln and Lane counties, showing a stretch of the coast and the mountains to the east, which rise rather steeply to elevations of 1,000 to 2,000 feet. The rugged, rocky coast in the southern part is succeeded in the central part of the area by a smooth sandy beach.

Pennsylvania.

Electric generating stations and transmission lines used in the public service in the State of Pennsylvania in 1920. Scale, 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

Oil and gas fields of the State of Pennsylvania: Scale, 1 inch=8 miles.

Similar to map of Illinois. (See p. 13.)

Rhode Island.

[See Massachusetts, etc.]

South Carolina.

[See also Georgia and South Carolina.]

*Aiken: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 33° 30' to 33° 45'; longitude, 81° 30' to 81° 45'.

Map of parts of Aiken and Edgefield counties, a rolling, hilly country whose highest points stand at elevations between 500 and 600 feet above the sea.

*Bowman: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 33° 15' to 33° 30'; longitude, 80° 30' to 80° 45'.

Map of parts of Orangeburg, Dorchester, and Calhoun counties, a region of low relief. Most of the larger valleys are flat-floored and swampy. The largest of the swamps is Four Hole Swamp, which is crossed by wagon roads at only three places in a distance of more than 18 miles.

*Orangeburg: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 33° 15' to 33° 30'; longitude, 80° 45' to 81°.

Map of parts of Orangeburg and Bamberg counties, a region of low relief through which Edisto River flows on a moderately wide marshy floor.

*Talatha: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 33° 15' to 33° 30'; longitude, 81° 30' to 81° 45'.

Map of parts of Aiken and Barnwell counties, a rolling, hilly country whose highest points stand only about 450 feet above the sea.

South Dakota.

State map: Scale 1 inch=8 miles.

Similar to base map of Kansas. (See p. 14.)

Texas.

*Bellaire: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 1 foot (except in the city of Houston). Latitude, 29° 37' 30" to 29° 45'; longitude, 95° 22' 30" to 95° 30'.

Map of part of the plain of Harris County, in eastern Texas, including the southwestern part of the city of Houston.

*Houston Heights: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 1 and 5 feet. Latitude, 29° 45' to 29° 52' 30"; longitude, 95° 22' 30" to 95° 30'.

Map of the western part of the city of Houston, in Harris County, and the nearly flat plain near that city. Buffalo Bayou traverses the southern part of the plain in a narrow, steep-sided trench.

*La Sal Vieja: Scale, 1 inch=1 mile; contour interval, 5 feet. Latitude, 26° 30' to 26° 45'; longitude, 97° 45' to 98°.

Map of parts of Kennedy, Willacy, and Hidalgo counties, a region of slight relief, dotted with numerous irregular depressions, many of which contain lakes.

*Marathon: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 30° to 30° 15'; longitude, 103° to 103° 15'.

Map of part of Brewster County, a region of irregularly distributed, rather narrow ridges separated by lowlands filled with desert wash.

*Monument Springs: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 30° to 30° 15'; longitude, 103° 15' to 103° 30'.

Map of part of Brewster County, a region characterized by the northward trending Del Norte Mountains and lower ranges to the east, which trend northeastward. Between the ranges are lowlands filled with desert washes.

*Park Place: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 1 and 5 feet. Latitude, 29° 37' 30" to 29° 45'; longitude, 95° 15' to 95° 22' 30".

Map of the southern part of the city of Houston, in Harris County, and the nearly flat plain near that city. In the northeastern part of the area is the Houston ship canal, which connects the city with Galveston Bay.

*Settegast: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 1 and 5 feet. Latitude, 29° 45' to 29° 52' 30"; longitude, 95° 15' to 95° 22' 30".

Map of the central and northeastern parts of the city of Houston, in Harris County, and the nearly flat plain close to that city.

*Tarida Ranch: Scale, 1 inch=1 mile; contour interval, 5 feet. Latitude, 26° 30' to 26° 45'; longitude, 97° 30' to 97° 45'.

Map of parts of Willacy and Cameron counties, only a short distance west of the Gulf. Few points in the area stand more than 35 feet above sea level. Numerous depressions, many of which are occupied by lakes and ponds, and many small mounds occur irregularly throughout the area.

United States.

Producing coal districts of the United States. Wall map, 48 by 75 inches, in two sheets. Scale, 1 inch=40 miles, approximately.

The map shows by a red overprint the outline of the areas in which coal is being produced and the names of the districts under which the areas are grouped.

Vermont.

[See also New Hampshire and Vermont.]

*Montpelier: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 44° 15' to 44° 30'; longitude, 72° 30' to 72° 45'.

Map of parts of Lamoille and Washington counties, a hilly region traversed by the Worcester Mountains, some of whose peaks rise more than 3,700 feet above sea level. Winooski River, the largest stream in the area, flows across the general trend of the hills, and the lower part of its valley is a succession of gorges.

Virginia.

[See also West Virginia and Virginia.]

*Big Stone Gap: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° 45' to 37°; longitude, 82° 45' to 83°. (Part of quadrangle.)

Map of parts of Wise and Lee counties. In the southern part of the region there are a number of nearly parallel ranges, which are succeeded to the north and west by higher hills that rise more than 4,000 feet above the sea. The larger streams flow in most places nearly parallel to the hills but at several places cut across them in narrow gaps, the most notable of which is Big Stone Gap.

Electric generating stations and transmission lines used in the public service in the State of Virginia in 1921. Scale, 1 inch=8 miles.

Similar to map of Delaware, etc. (See pp. 12-13.)

*Wise: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° 45' to 37°; longitude, 82° 30' to 82° 45'.

Map of parts of Wise and Scott counties, a dissected mountainous region, some of whose peaks rise more than 4,000 feet above the sea but whose lowest points are less than 1,300 feet high.

Washington.

*Walla Walla: Scale, 1 inch=2 miles; contour interval, 50 feet. Latitude, 46° to 46° 30'; longitude, 118° to 118° 30'.

Map of parts of Walla Walla and Columbia counties, a region in whose southeastern part are the Blue Mountains, about 4,500 feet above sea level. Northwest of the mountains is a plateau whose upland stands about 2,000 feet above sea level but which has been minutely dissected.

West Virginia.

[See also Maryland and West Virginia.]

*Moorefield: Scale, 1 inch=1 mile; contour interval, 50 feet. Lat.tude, 39° to 39° 15'; longitude, 78° 45' to 79°.

Map of parts of Hampshire and Hardy counties, a region crossed by rather massive mountains, some of whose summits stand more than 3,000 feet above the sea. A large part of the area is drained by the South Branch of Potomac River and its tributaries.

*Onego: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude 38° 45' to 39°; longitude, 79° 15' to 79° 30'.

Map of parts of Pendleton, Randolph, Tucker, and Grant counties. The southeastern part of the area is characterized by linear ridges and valleys underlain by folded rocks. The northwestern part, however, is an extensive plateau, which is underlain by nearly flat-lying rocks and forms part of the Appalachian Plateau province.

West Virginia and Maryland.

[See also Maryland and West Virginia.]

*Davis: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 39° to 39° 15'; longitude, 79° 15' to 79° 30'.

Map of parts of Grant and Tucker counties, W. Va., and Garrett County, Md., a region of striking topographic forms, in the eastern part of which are the steep, rugged slopes of the Allegheny Front. Westward these slopes give place to more open, rolling plateau topography.

West Virginia and Virginia.

*Petersburg: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 38° 45' to 39°; longitude, 79° to 79° 15'.

Map of parts of Hardy, Grant, and Pendleton counties, W. Va., and Rockingham County, Va., a region of nearly parallel mountain ranges separated from one another by the South Branch of Potomac River and its tributaries.

Wisconsin.

Kendall: Scale 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° 45' to 44°; longitude, 90° 15' to 90° 30'.

Map of parts of Monroe and Juneau counties, a dissected plateau country at elevations of 900 to 1,400 feet above the sea.

Wyoming.

Oil and gas fields of the State of Wyoming: Scale, 1 inch=8 m.les.

Similar to map of Illinois. (See p. 13.)

Saddleback Hills: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 41° 45' to 42°; longitude, 106° 15' to 106° 30'.

Map of part of Carbon County, practically all of which stands at an elevation of more than 6,500 feet, and the highest points at more than 7,800 feet. The Saddleback Hills are formed by two sharp ridges that converge and unite toward the north and mark a structure produced by the folding of the rocks of which they are made.

GEOLOGIC BRANCH.

The geologic branch, under the supervision of David White, chief geologist, consists of three divisions:

1. The division of geology (Sidney Paige, geologist in charge) conducts areal geologic surveys and special scientific and economic investigations and researches. It is engaged in preparing the geologic map of the United States and in studying the geology of mineral deposits; and through field examinations it cooperates in the classification of the mineral lands of the public domain.

2. The division of mineral resources (G. F. Loughlin, geologist in charge) keeps the public informed as to the state of the mineral industries and the rate of production of mineral commodities in the United States. This division also

compiles and prepares for publication information concerning foreign mineral deposits—their geology, quality, reserves, state of development, output, and trade distribution. Branch offices of this division are maintained at San Francisco, Salt Lake City, and Denver.

3. The division of chemical and physical research (George Steiger, chief chemist, acting in charge) makes the chemical analyses that are essential to the work of the geologic branch and conducts physical and chemical researches bearing on geologic problems.

The division of Alaskan mineral resources (Alfred H. Brooks, geologist in charge) was on April 1 made an independent branch, and the account of its work will be found on pages 38–41.

DIVISION OF GEOLOGY.

ORGANIZATION AND PERSONNEL.

At the beginning of the year the scientific force of the division of geology consisted of 86 geologists, 12 associate geologists, 15 assistant geologists, 13 geologic aids, 2 junior geologists, and 1 mineral geographic aid. During the year 4 geologists, 1 assistant geologist, and 2 geologic aids resigned and 1 assistant geologist died, making a total of 8 separations. One geologist and one assistant geologist were appointed during the year. As the result of these changes and of promotions, the total at the end of the year was 123, including 86 geologists, 9 associate geologists, 13 assistant geologists, 11 geologic aids, 2 junior geologists, 1 mineral geographic aid, and 1 junior topographer (title changed from geologic aid).

The division is organized in the ten sections named below, and it also exercises administrative supervision of the section of geologic map editing, a part of the publication branch.

Areal geology: Sidney Paige, geologist in charge.

Geology of metalliferous deposits: F. L. Ransome, geologist in charge.

Geology of nonmetalliferous deposits: G. R. Mansfield, geologist in charge.

Coastal Plain investigations: L. W. Stephenson, geologist in charge. Includes the subsection of investigations of sedimentation, T. W. Vaughan, geologist in charge.

Glacial geology: W. C. Alden, geologist in charge.

Paleontology and stratigraphy: T. W. Stanton, geologist in charge.

Geology of coal fields: M. R. Campbell, geologist in charge.

Geology of oil and gas fields: K. C. Heald, geologist in charge.

Geology of iron and steel metals: E. F. Burchard, geologist in charge.

Petrology: E. S. Larsen, jr., geologist in charge.

FINANCIAL STATEMENT.

The total funds available for the geologic work of the Survey in the United States for the fiscal year 1920–21 were as follows:

Geologic surveys	\$352,000
Repayments	7,433
Classification of lands.....	38,750
Scientific assistants	17,700
Search for potash deposits (part of appropriation for chemical and physical researches).....	7,250
	<hr/>
	423,133

The authorized expenditures, classified by subjects, were approximately as follows:

Economic geology of metalliferous deposits.....	\$57, 150
Economic geology of nonmetalliferous deposits.....	13, 075
Economic geology of fuels (oil, gas, coal).....	123, 540
Scientific researches not directly connected with economic geology (paleontology, glaciation, Coastal Plain formations, etc.)	117, 122
Supervision, administration, salaries of clerical, technical, and skilled-labor forces, purchase and repair of instruments, office supplies, etc.....	112, 246
	<hr/> 423, 133

Of the amounts available for geologic work, \$100,000 was used directly for field expenses, including the search for potash. About 80 per cent of this amount was expended west of the one hundredth meridian, and about 20 per cent east of it.

COOPERATION.

A brief outline of the scope of the Survey's activities in both formal and informal cooperation, which are largely continuous from year to year, will be found on page 45 of the Forty-first Annual Report. The principal cooperative projects of the current year are noted in the account of the work by States.

SPECIAL FEATURES.

For those concerned with the application of geology to practical affairs it is worth noting that in four oil fields—Mexia, Tex.; Burbank, Okla.; Bellevue, La.; and the Sweet Grass Hills, Mont.—geologic mapping by the United States Geological Survey had proved the existence of oil-bearing structural features prior to the extensive development that has since taken place. The policy of undertaking the intensive study of possible oil-bearing territory in advance of commercial development will be continued in so far as funds are available. During the year a party began the study of the region about the northern rim of the Black Hills with a view to appraising its broad possibilities as a petroleum producer. Detailed studies of correlation are being made in northern Colorado and southern Wyoming with a view to clearing up a number of debated questions regarding the age and stratigraphic position of important oil sands. This work, which consists in the accurate measurement of sections sufficiently near together that little opportunity for error can creep in, has already thrown much light on the geologic history of the region. Year by year such work is more certainly recognized as of first importance to those concerned with subsurface geology and its direct application to the exploration for oil. The prompt issue of press bulletins presenting the results of recent field work, accompanied by simple maps showing newly discovered structural features favorable for oil, has proved very useful to the public. The chief geologist has given some attention to the occurrence, nature, and origin of oil shale, but it is hoped that in the future many puzzling problems for the chemist and the biologist may receive increasing attention. Systematic investigations of oil shale by the Survey, although interrupted for some years, will be resumed, it is hoped, at an early date.

With the cordial cooperation of the Coast and Geodetic Survey, studies are being carried on to discover the possibility of correlating gravity determinations (by pendulum observations) with geologic structure and major units of rock masses. The spirit of broad inquiry and desire on the part of the Coast Survey to offer every assistance in this work is gratifying. The results of these investigations, which may have very practical application, will be published in due course.

Laboratory studies undertaken by the subsection of sedimentation have been materially advanced through the cordial cooperation of the Bureau of Soils, particularly through the work of Milton Whitney, chief of that bureau, whose study of colloids in soils is of direct application in the interpretation of sedimentary processes.

During the year the water-resources branch of the Survey made comprehensive studies of portions of Colorado and San Juan rivers in Utah and Arizona with a view to determining the suitability of various dam and reservoir sites. Geologists accompanied all the parties engaged in this work, and it was thereby made possible to gain abundant geologic information concerning an extensive region that had been previously little known and is particularly difficult of access. This is the first time that surveys of scientific exploration have been carried the length of San Juan River. Geologic studies were also made by river from Green River, Utah, to Lees Ferry, Ariz., including that portion of the canyon known as the Cataract Canyon. Observations over so extensive an area have added materially to the knowledge of the stratigraphy and structure of this region, and with respect to the occurrence of oil they are of immediate practical value.

It has long been recognized as desirable to attempt more reconnaissance explorations of the vast areas in the West that are practically unknown, and, so far as funds will permit, it is hoped to perform some of this semiexploratory work each year. One project of this sort to be carried out at the present time is a detailed reconnaissance of the Tonopah quadrangle, Nevada, an area of 4,000 square miles. A similar project is the preparation of a geologic map of Arizona in cooperation with the State Bureau of Mines, now in progress.

An extensive field investigation of the radium-bearing carnotite ores of the United States has been practically completed, as well as a similar study of the tungsten deposits of the United States. Reports on both of these subjects are now in preparation.

Studies of the complexly folded and metamorphosed pre-Cambrian and Paleozoic rocks of the Maryland and Pennsylvania Piedmont areas have settled a number of puzzling stratigraphic and structural questions of long standing. Several field conferences have been held, in which the State geologists of Maryland and Pennsylvania joined, and it may be said that the present state of knowledge of this terrane marks a distinct advance in American geology.

The division has cooperated with the geophysical committee, organized on the Pacific coast under the auspices of the Carnegie Institution, in a study of earth movements in connection with earthquakes. In connection with this study considerable detailed mapping has been done along the San Andreas fault, also considerable reconnaissance surveying.

Discoveries made in the course of boring for oil in Texas point to the probable presence of layers of potash-bearing salts in commercial quantities. Because of lack of funds on the part of the Bureau of Economic Geology and Technology of Texas cooperative arrangements for this work were terminated in November, but it is planned to continue the work on an even more comprehensive scale.

At the request of the United States Reclamation Service a number of geologists have cooperated with the engineers of that service in geologic studies of dam and reservoir sites. This highly practical application of geology is particularly satisfying to those to whom usefulness and public service are synonymous.

Geologic surveys under the general direction of the United States Geological Survey have been carried out by the Haitian Government, and a report on the geology of the Republic is in progress. Similar work for the Dominican Republic ceased in 1919. A geologic reconnaissance report on the Dominican Republic was issued by the Dominican Government during the year.

Additions have been made by Survey geologists to the status of areal geologic mapping and the correlation of the post-Cretaceous geologic formations in the Pacific region in two symposia published in the Proceedings of the First Pan-Pacific Scientific Conference.

As a result of the work done by Survey geologists on the paleontology and correlation of the Tertiary formations of eastern Mexico the major divisions of the Tertiary section have been discriminated and biologically characterized, so that the Mexican formations can now be correlated with Tertiary formations of the southern United States, the West Indies, and eastern Central America.

Definite progress has been made in the investigation of the calcium carbonate deposits of the Floridian and Bahaman regions. A fairly full statement of these researches is given in the report of the Committee on Sedimentation of the National Research Council.

WORK OF THE DIVISION, BY STATES.

[Brief notices of the publications issued during the year are given on pp. 4-10.]

ALABAMA.

Field work.—Charles Butts carried on stratigraphic studies in Alabama, including the examination of several geologic sections near Triana. Mr. Butts also examined proposed additions to the Appalachian National Forest. E. F. Burchard studied brown ores and cement rock.

Office work.—A report on southern Alabama and western Florida was begun by C. W. Cooke, who also compiled a geologic map for a relief model of Alabama and Florida. Collections of Tertiary fossils made in Alabama were examined by Julia A. Gardner and Mr. Cooke. The Bessemer-Vandiver and Columbiana-Montevallo folios were completed by Charles Butts. R. D. Mesler prepared collections of fossils for examination. E. O. Ulrich studied fossils from the Chester formation.

ARIZONA.

Field work.—N. H. Darton continued geologic studies in cooperation with the Arizona Bureau of Mines, the results to be used in the preparation of a map of the State. Sidney Paige studied the geology of Green and Colorado rivers between Green River, Utah, and Lees Ferry, Ariz., accompanied in Arizona by H. D. Miser. C. P. Ross studied the geology and ore deposits of the Christmas quadrangle.

Office work.—G. H. Girty and J. B. Reeside, Jr., examined fossils collected by Mr. Darton. Mr. Girty continued studies of the Triassic faunas of the State, and a paper on stratigraphic sections in southwestern Utah and north-

western Arizona was completed by Mr. Reeside. A report on the rock formations in the Colorado Plateau of southeastern Utah and northern Arizona by H. D. Miser, C. R. Longwell, R. C. Moore, Kirk Bryan, and Sidney Paige was continued. W. H. Dall worked on fossils collected by N. H. Dart. F. L. Ransome completed a reconnaissance report on the Pima and Pinal mining districts, revised a paper on the Sierrita Mountains, and continued the preparation of a report on the Oatman mining district. L. F. Noble continued the preparation of a report on nitrate in the Mohave Desert and the valley of Colorado River, which includes a few deposits in Arizona. T. Stanton reported on collections of Triassic faunas. Edward Sampson prepared a paper on the origin of serpentine in the limestone type of asbest deposit.

Publications.—Issued: Prof. Papers 129-D, 129-H; Bulletins 725-J, 730-I press notice, "Mining districts near Tucson, Ariz." In press: "A section of the Paleozoic formations of the Grand Canyon at the Bass trail," by L. Noble (Prof. Paper 131-B); "Silver ores near Wickenburg, Ariz.," by E. Bastin (Bulletin 735-E).

ARKANSAS.

Field work.—E. F. Burchard examined Poteau Mountain, Ark., and prepared a report on the lands on this mountain for the Forest Service. Geological work was done in the vicinity of St. Joe and Duff by R. D. Mesler. W. V. Rubey, assisted by L. G. Mosburg and H. W. Hoots, collected drill records and made studies for a report on the El Dorado oil field. K. C. Heald visited this field and inspected the work.

Office work.—W. W. Rubey continued the preparation of a report on the El Dorado oil field and, with James Gilluly and K. C. Heald, prepared preliminary notices on this field. A folio covering the De Queen and Caddo Gap quadrangles was completed by H. D. Miser. Mr. Miser and C. S. Ross prepared papers on peridotite dikes in Scott County and diamond-bearing peridotite, Pike County. Cretaceous fossils from Arkansas were studied by L. W. Stephenson, R. D. Mesler studied the Normanskill and associated faunas, and G. J. Girty studied the Boone fauna.

Publications.—Issued: Press notices, "El Dorado oil field in Arkansas not on an anticline," "Wildcat wells in south-central Arkansas stop short of deep oil sands," "Oil from the Nacatoch sand, El Dorado, Ark." In press: "Manganese deposits of the Batesville district, Ark.," by H. D. Miser (Bulletin 734).

CALIFORNIA.

Field work.—J. S. Diller carried on further studies in the Lassen Peak volcanic area, Calif. W. S. W. Kew completed his studies of the oil geology of the Santa Monica, Redondo, and San Pedro quadrangles and carried on triangulation in the San Pedro Hills, preparatory to geologic mapping for a report on the oil geology of Los Angeles County. The Elk Hills were visited in September by K. C. Heald and Mr. Kew, who inspected the area covered by Naval Reserve No. 1 and planned for detailed mapping. F. L. Hess examined deposits of tuff in the vicinity of San Francisco and Randsburg. L. F. Noble examined the San Andreas rift. F. E. Matthes carried on physiographic studies of the Sierra Nevada, from the Yosemite region eastward to the east border of the Mount Lyell quadrangle. J. M. Hill studied the copper deposits of Plumas County.

Office work.—J. S. Diller completed his report on the Lassen Peak volcanic district, revised the text of the Riddle folio, and prepared a brief paper on the geology and physiography of the Klamath River basin. E. S. Larsen prepared a paper for outside publication on merwinite, a new mineral from the vicinity of Riverside. F. E. Matthes has completed a geologic report on the Yosemite National Park and is preparing a report on the Green River and Table Mountain region of the Sierra Nevada. J. M. Hill prepared a paper covering the mining industry of California and Oregon. A report on the Los Angeles-Ventura district, prepared during the fiscal year 1921-22, was revised by W. S. W. Kew. H. Dall reported on Eocene fossils from Catalina Island and southern California and on Pleistocene fossils from Indian Wells Valley.

Publications.—Issued: Bulletins 721, 725-A. In press: "Nitrate deposits of the Amargosa region, southeastern California," by L. F. Noble, G. R. Mansfield, and others (Bulletin 724).

COLORADO.

Field work.—J. D. Sears, assisted by C. P. Ross, carried on geologic work in the Axial and Monument Butte quadrangles, Colo., and Mr. Sears, assisted by W. H. Bradley, K. K. Landes, and James Gilluly, did geologic work in Moffat County. Mr. Sears also visited the Rangely oil field for the land-classification board. H. D. Miser was engaged in geologic studies along San Juan River in this State, in cooperation with a party of hydraulic engineers. T. W. Stanton made stratigraphic studies near Morrison and Colorado Springs.

Office work.—E. S. Larsen completed a report on the geology and ore deposits of the Creede district and continued work on a report covering the geology of the San Cristobal quadrangle. C. P. Ross, E. S. Larsen, and C. W. Cross continued the preparation of a report on the igneous geology of the San Juan region. Kirtley Mather, assisted by W. W. Atwood, continued the preparation of a paper on the physiography and Quaternary geology of the San Juan Mountains. F. H. Knowlton began a study of the fossil plants of the Animas formation and completed a paper on the Green River flora. J. B. Reeside, jr., continued the preparation of a report on the Cretaceous and Tertiary formations of the west side of the San Juan Basin of Colorado and New Mexico. Mr. Reeside also examined fossils collected by W. T. Lee. M. R. Campbell prepared a report on the classification data of the Yampa coal field, also a report on the Twentymile Park district. J. D. Sears prepared a report on the structure and oil possibilities of parts of Moffat County. W. T. Lee prepared a paper on stratigraphic problems in northern Colorado and southern Wyoming. Cretaceous plants from Colorado were reported on by F. H. Knowlton for Messrs. Lee and Reeside. G. H. Girty reported on fossils from this State. W. T. Lee prepared a report that included discussions of the stratigraphy of the Dakota group east of the Rocky Mountain front and treated briefly the significance of these stratigraphic descriptions in connection with possible oil development.

Publications.—Issued: Bulletin 730-A; press notice, "The Yampa coal field, in northwestern Colorado." In press: "The Laramie flora of the Denver Basin," by F. H. Knowlton (Prof. Paper 130); "Guidebook of the western United States—Part E, The Denver & Rio Grande Western Route," by M. R. Campbell (Bulletin 707); "The geology and ore deposits of the Creede district, Colo.," by W. H. Emmons and E. S. Larsen (Bulletin 718); "Silver enrichment in the San Juan Mountains, Colo.," by E. S. Bastin (Bulletin 735-D).

DISTRICT OF COLUMBIA.

Field work.—C. K. Wentworth studied the origin and nature of the Coastal Plain terraces in the District of Columbia and collected samples of gravel. C. W. Cooke gave some attention to the geology and ground waters at several places.

FLORIDA.

Office work.—C. W. Cooke began a report on the geology of western Florida and southern Alabama and continued the preparation of a geologic map and profile for a relief model of part of Alabama and Florida. T. W. Vaughan and Julia A. Gardner examined fossils from Florida. Miss Gardner worked on her report on the Alum Bluff Mollusca. Mr. Vaughan studied calcium carbonate bottom samples collected from this State. W. H. Dall reported on fossils from St. Petersburg.

GEORGIA.

Field work.—C. W. Cooke made geologic studies in connection with the revision of a geologic map of Georgia in cooperation with the State.

Office work.—J. A. Gardner examined collections of fossils from Georgia. C. W. Cooke prepared a paper on prehuman history, describing the geologic history of the region around Macon, for the Mexican Geographic Magazine.

IDAHO.

Field work.—Edward Sampson and J. L. Gillson studied the geology and mines in the Pend Oreille region in cooperation with the State of Idaho. Mr. Sampson visited the asbestos deposits near Henry Lake. J. T. Pardee studied the Pleistocene features of Clark Fork valley in northern Idaho.

Office work.—A report by the Idaho Bureau of Mines and Geology on "Oil prospects in southeastern Idaho" was critically reviewed by K. C. Heald. A report on oil and gas prospects of southwestern Idaho is now in preparation by J. P. Buwalda. G. R. Mansfield classified phosphate lands in the Lanes Creek, Freedom, Crow Creek, Slug Creek, Montpelier, Cranes Flat, and Henry quadrangles, Idaho and Wyoming, continued the preparation of a report on the geology and mineral resources of southeastern Idaho, and completed a paper on the climate of southeastern Idaho. Edwin Kirk reported on fossils for Edward Sampson, who is preparing a report on the geology of the Pend Oreille region. G. H. Girty and F. H. Knowlton examined collections of Triassic and Tertiary fossils from the State, and Mr. Girty worked on a short paper entitled "The Triassic of Idaho."

Publication.—In press: "Geology and ore deposits of Shoshone County, Idaho," by J. B. Umpleby and E. L. Jones, jr. (Bulletin 732).

ILLINOIS.

Field work.—The Waterloo-Columbia field, Ill., was visited by W. W. Rubey, who studied its bearing on the possibilities of finding oil in Missouri.

Publication.—Issued: Geologic Folio 218.

INDIANA.

Field work.—Charles Butts, in cooperation with A. C. Mallott, of Indiana University, investigated stratigraphic problems relating to the Chester group.

KANSAS.

Office work.—The age of the Stapleton oil sand of the Eldorado field, Kans., was discussed by A. E. Fath in a paper published in the Bulletin of the American Association of Petroleum Geologists.

Publication.—Issued: Prof. Paper 129-I.

KENTUCKY.

Field work.—David White examined deposits of oil shale at a number of localities in Kentucky.

Office work.—Further work was done by Charles Butts on the Equality-Shawneetown folio. E. O. Ulrich made investigations of the Chester material from this State. Mr. Ulrich and the State geologist of Maryland held conferences regarding Kentucky stratigraphy. The oil and gas field map of Kentucky was compiled by L. B. Pusey, under the direction of G. B. Richardson, and submitted for publication.

Publication.—A paper on the Mississippian formations of eastern Kentucky, by Charles Butts, was issued by the State Geological Survey.

LOUISIANA.

Office work.—T. W. Stanton reported on Comanche fossils from a deep well in Caddo Parish, La., and T. W. Vaughan reported on collections from this State. Julia A. Gardner made determinations of well samples from Louisiana. W. H. Dall made a report on Pleistocene material.

MARYLAND.

Field work.—C. K. Wentworth continued his studies of the Coastal Plain terraces in Maryland. Anna I. Jonas carried on geologic mapping in Carroll County. Asbestos and talc deposits near Conowingo were examined by Edward Sampson. E. O. Ulrich and B. D. Mesler made paleontologic studies of the Clinton formation at Cumberland.

Office work.—A report on the crystalline rocks of Baltimore County, Md., was finished and transmitted to the State geologist of Maryland by Eleanor Bliss Knopf and A. I. Jonas.

Publication.—Issued: Bulletin 725-B.

MASSACHUSETTS.

Field work.—Laurence LaForge completed his studies in Boston, Mass., and vicinity, the results of which are to be incorporated in the Boston folio. L. M. Prindle completed his investigations in the Hoosick, Bennington, Berlin and Greylock quadrangles.

Office work.—Preparation of the Boston folio was continued by Laurence LaForge. L. M. Prindle continued office work on the folio covering the Hoosick, Bennington, Berlin, and Greylock quadrangles. A report on the Quaternary geology of eight quadrangles in central Massachusetts was revised by W. C. Alden.

MICHIGAN.

Field work.—The surface geology of the Stockbridge and Rives Junction quadrangles, Mich., was mapped by Frank Leverett, in cooperation with the State Survey.

Office work.—The 100-foot contours and surface geology of the map of the southern peninsula of Michigan which appears in Monograph 53 were revised by Frank Leverett, who also made copies of the maps showing the Quaternary geology of the Schoolcraft, Springport, Rives Junction, Stockbridge, Flint, Holly, and Durand quadrangles for the use of the Michigan Geological Survey. A small amount of time was devoted by Mr. Leverett to the manuscript of a report on the region around Camp Custer. A paper on eakleite from Isle Royale was prepared by E. S. Larsen for outside publication.

MINNESOTA.

Office work.—The Pleistocene geology of Minnesota was studied by Frank Leverett, and a report on the subject was in course of preparation during the year. He also prepared a scientific paper on certain glacial features of the State for the meeting of the Geological Society of America.

MISSISSIPPI.

Publications.—Issued: Prof. Paper 129-E; press notice, "Possible indications of oil in Mississippi."

MISSOURI.

Field work.—Stratigraphic and structural conditions in Missouri bearing upon the possibilities of undiscovered oil fields were studied by W. W. Rubey during August and September. Frank Leverett studied the relations of the older glacial drifts of northwestern Missouri.

Office work.—An estimate of the petroleum reserves of Missouri was made by W. W. Rubey during October and submitted to the joint committee of the Geological Survey and the American Association of Petroleum Geologists. A complete set of cuttings from a well in Vernon County was prepared for study and examined in a preliminary way by Mr. Rubey in February. Paleontologic studies were made by G. H. Girty and E. O. Ulrich.

MONTANA.

Field work.—Detailed structure mapping of the Crow Indian Reservation, with particular attention to anticlinal structure that appeared favorable for oil and gas, was done by W. T. Thom, jr., assisted by Gail F. Moulton, and further field work was done by Mr. Thom, assisted by W. W. Rubey. The Glendive (Cedar Creek) anticline was mapped by Mr. Moulton, N. W. Bass, and M. N. Bramlette. Mr. Thom outlined the work for this party and stayed with them for the first week. Reconnaissance mapping in northern Fergus County was carried on by Frank Reeves, assisted by James Gilluly, L. C. Fenstermacher, J. B. Eby, and M. N. Bramlette. A number of domes south of the Little Rocky Mountains that might be favorable for oil accumulation were mapped by A. J. Collier and S. H. Cathcart in the course of their work in the Fort Belknap Indian Reservation. Mr. Collier, assisted by W. W. Boyer, examined the Sweet Grass arch. Work in the northern Big Horn Basin was begun by R. S. Knappen, assisted by Gail F. Moulton.

Office work.—Two press bulletins describing structural conditions and oil development in the Soap Creek field in the Crow Indian Reservation and a paper discussing the oil prospects of a number of anticlinal folds in the reservation were prepared by W. T. Thom, jr. Progress was made on a report covering the area in Fergus County mapped during the fiscal years 1920-21 and 1921-22, but no report was submitted, with the exception of data for the use of the land-classification board. A report by Mr. Thom on the

geology and oil and gas prospects of eastern Montana was completed and issued as a press bulletin. Mr. Thom and C. E. Dobbin spent some time working on a map showing geologic structure in the Dakota sandstone in eastern Montana. A report on the oil prospects of the Cedar Creek anticline was prepared by Mr. Thom and Gail F. Moulton and issued as a press bulletin. A report on the structural features favorable for oil in Garfield County was prepared by Messrs. Thom and Dobbin and issued as a press bulletin. Incidentally data for land classification in eastern and southern Garfield County were submitted to the land-classification board. The mapping of the geologic structure of the southwestern part of the Lake Basin field was revised by Mr. Thom, and a press bulletin calling attention to favorable features and prospects for oil and gas was issued. A report describing the geologic structure and possible economic significance of laccolithic domes south of the Little Rocky Mountains was prepared by A. J. Collier. Mr. Collier prepared land-classification data covering oil possibilities in the Fort Belknap Indian Reservation for the land-classification board. Edwin Kirk reported on fossils collected by Mr. Collier. G. H. Girty reported on fossils from the State. J. T. Pardee prepared a report on the glacial geology and origin of gold-bearing gravels of the Pioneer district and completed a report on ground water in the vicinity of Townsend. W. C. Alden continued the preparation of a report on the Cenozoic history of Montana, in which he describes the Tertiary and Pleistocene bench gravels east of the Rocky Mountains. T. W. Stanton studied the invertebrate fossils from the Lance formation.

Publications.—Issued: Bulletins 725-A, 725-C; press notices, "The Ingomar dome, Mont.," "The Soap Creek oil field, Crow Indian Reservation, Mont.," "Recent drilling in the Soap Creek oil field, Crow Indian Reservation, Mont.," "Oil and gas may be found in the Eagle sandstone in the Lake Basin field, Mont.," "Geology of northern Fergus County, Mont.," "Oil and gas prospects in Garfield County, Mont.," "Oil and gas prospects in the Cedar Creek anticline and vicinity, in Montana, North Dakota, and South Dakota." In press: "Oil and gas prospects in and near the Crow Indian Reservation, Mont.," by W. T. Thom, jr. (Bulletin 736-B); "Possibility of finding oil in laccolithic domes south of the Little Rocky Mountains, Mont.," by A. J. Collier and S. H. Cathcart (Bulletin 736-F).

NEBRASKA.

Field work.—Reported gas seepages near Grand Island, Nebr., were examined by K. C. Heald. T. W. Stanton made stratigraphic studies near Crawford and collected Cretaceous and invertebrate fossils. Frank Leverett studied the relations of the older glacial drift in Nebraska.

NEVADA.

Field work.—Reported occurrences of oil near Fallon, Nev., were examined by D. F. Hewett, who also investigated underground water resources near Searchlight and, with C. H. Behre, examined carnotite deposits near Jean. G. R. Mansfield and L. F. Noble visited the Callville borax deposits. H. G. Ferguson and party began the mapping of the Tonopah quadrangle. G. H. Girty continued studies of Triassic faunas of the State. F. L. Hess studied the deposits of vanadium ore near Goodsprings.

Office work.—Adolph Knopf continued the preparation of a report on the Rochester district and completed a report on the Candelaria district. The report on the Jarbidge district was revised by F. C. Schrader. Fossils from various parts of the State were examined by W. H. Dall, Edwin Kirk, and T. W. Stanton. D. F. Hewett completed a geologic map of the Goodsprings quadrangle and continued the preparation of a report on the manganese resources of the State. A report on the Manhattan mining district was completed by H. G. Ferguson. L. F. Noble completed a report on the colemanite deposits in Clark County.

Publications.—Issued: Bulletins 725-H, 725-I, 735-A, 735-B, 735-C; press notices, "The Comstock lode probably still far from exhausted," "Colemanite in the Muddy Mountains, Nev."

NEW HAMPSHIRE.

Field work.—Arthur Keith continued studies of the stratigraphy of central New Hampshire.

NEW JERSEY.

Office work.—G. R. Mansfield revised and completed a bulletin on the New Jersey greensands.

Publication.—In press: "Potash in the greensands of New Jersey." by G. R. Mansfield (Bulletin 727).

NEW MEXICO.

Office work.—J. B. Reeside, jr., made progress on a report on the Cretaceous and Tertiary formations of the west side of the San Juan Basin of Colorado and New Mexico. J. D. Sears prepared a report on the Gallup-Zuni area. W. T. Lee continued the preparation of a folio on the Raton, Brilliant, and Koehler quadrangles. H. G. Ferguson began a detailed report on the Mogollon mining district. F. H. Knowlton studied the fossil plants of the Animas formation.

Publications.—Issued: Bulletins 725-G, 728-E. In press: "Copper deposits of the Tyrone district, N. Mex.," by Sidney Paige (Prof. Paper 122).

NEW YORK.

Field work.—Studies in the Hoosick and Bennington quadrangles, lying partly in New York, were completed by L. M. Prindle. Charles Butts spent a short time in a study of Niagara Gorge and Eighteenmile Creek. He also examined the Portage formation at Mount Morris and collected samples of black shale for oil tests. T. W. Vaughan made field examinations in Essex County and studied the geology and physiography of the Hudson Valley and Lake Champlain region in connection with the correlation of Pleistocene formations along the Atlantic coast. Samples of carbonaceous Devonian shale at several points in the western part of the State were collected by David White. E. S. Larsen studied the occurrence of the mineral serendibite in Warren County.

NORTH CAROLINA.

Field work.—W. S. Bayley studied the magnetites of North Carolina and the limonites of Cherokee County in cooperation with the State Geological Survey. E. F. Burchard examined iron-ore deposits in Ashe and Cherokee counties, conferring with W. S. Bayley and J. H. Pratt in the field. M. R. Campbell, assisted by K. K. Kimball, made geologic studies of the Deep River coal field. Julia A. Gardner studied fossil faunas of the Miocene and Pliocene of Virginia and North Carolina in connection with a report on Miocene and Pliocene gastropods and pelecypods. G. R. Mansfield investigated the lights seen in the vicinity of Brown Mountain.

Office work.—W. S. Bayley prepared a paper on the brown iron ores of western North Carolina in cooperation with the State Geological Survey. Arthur Keith completed the Kings Mountain-Gaffney folio.

Publications.—Issued: Bulletin 725-B; press notices, "Origin of the lights at Brown Mountain, N. C.," "Small field of high-grade coal in North Carolina." In press: "General features of the brown hematite ores of western North Carolina," by W. S. Bayley (Bulletin 735-F).

NORTH DAKOTA.

Field work.—The mapping of the Baker-Glendive anticline of Montana extended into southwestern North Dakota.

Office work.—A report on the Baker-Glendive anticline was prepared by W. T. Thom, jr., and Gail F. Moulton.

Publications.—Issued: Bulletin 726-D; press notices, "Oil and gas prospects in the Cedar Creek anticline and vicinity. In Montana, North Dakota, and South Dakota," "New report on the lignite of North Dakota."

OHIO.

Field work.—E. O. Ulrich made paleontologic studies in Adams County, Ohio. David White collected samples of carbonaceous shales.

Office work.—G. H. Girty studied fossils collected from this State.

Publication.—In press: "Economic geology of the Summerfield and Woodsfield quadrangles, Ohio," by D. D. Condit (Bulletin 720).

OKLAHOMA.

Field work.—The oil and gas resources of eastern Grant County, Okla., were studied by R. S. Knappen, assisted by H. W. Hoots. The Burbank field was examined by K. C. Heald, assisted by Clarence Byler. Mr. Heald attended three sales of leases in the Osage Nation and gave advice as to the adequacy of bids received. Physiographic studies were made in Oklahoma by N. M. Fenneman.

Office work.—A press bulletin describing anticlinal structure in Grant County was prepared by R. S. Knappen. Progress was made on a bulletin discussing the oil geology of the county. A report on the structure and oil resources in Tps. 26 and 27 N., R. 12 E., Osage County, was completed and submitted for publication by P. V. Roundy and K. C. Heald. A report on the oil geology of the Bristow quadrangle was completed by A. E. Fath. A progress report on the subsurface conditions in the Pershing field, Osage County, was completed by W. W. Rubey. P. V. Roundy studied samples of drill cuttings from Oklahoma, particularly from fields in Stephens County. N. M. Fenneman prepared a paper on physiographic studies within the State. G. H. Girty studied the Boone fauna. T. W. Stanton made studies of the Comanche fossils from this State. C. E. Siebenthal studied the geology and zinc mines of the Wyandotte quadrangle.

Publications.—Issued: Bulletins 725-E, 726-B, 726-F, 736-A; press notices, "Undiscovered oil pools in southern Oklahoma," "Possibilities of oil in Grant County, Okla." In press: "Structure and oil and gas resources of the Osage Reservation, Okla.—Tps. 26 and 27 N., R. 12 E." by P. V. Roundy, K. C. Heald, and G. B. Richardson (Bulletin 686-Z); "Physiographic provinces and sections in western Oklahoma and adjacent parts of Texas," by N. M. Fenneman (Bulletin 730-D).

OREGON.

Office work.—F. H. Knowlton and T. W. Stanton reported on fossils from the Wallowa Mountains, Oreg. J. M. Hill prepared a preliminary review on the mining industry in California and Oregon. J. S. Diller has in preparation a paper on the engulfment of Mount Mazama to form a great pit for Crater Lake.

Publication.—Issued: Bulletins 725-A, 725-C.

PENNSYLVANIA.

Field work.—K. K. Kimball, assisted by L. P. Foley and R. P. Paxson, continued work in the New Kensington quadrangle, Pa. General geologic work in the McCallis Ferry and Quarryville quadrangles was done by E. B. Knopf and A. I. Jonas. In cooperation with the Pennsylvania Bureau of Topographic and Geological Survey Miss Jonas studied the geology of Lancaster and York counties. Areal and structural mapping of the New Kensington quadrangle was continued by G. B. Richardson and assistants. David White collected samples of carbonaceous shale. G. W. Stose, in cooperation with Florence Bascom, made detailed geologic studies of the Honeybrook quadrangle. Mr. Stose carried on reconnaissance mapping in the Hanover quadrangle.

Office work.—Work on a report on the New Kensington quadrangle was done by K. K. Kimball. A map showing the oil fields of Pennsylvania was compiled by L. B. Pusey under the direction of G. B. Richardson. E. O. Ulrich reported on specimens from the Freedomville dolomite and on certain fossiliferous pebbles for C. K. Wentworth. G. H. Girty made paleontologic studies of Triassic material from the State. The Bellefonte folio was partly revised by Charles Butts.

Publication.—Issued: Bulletin 725-B.

SOUTH CAROLINA.

Field work.—C. W. Cooke spent some time in the field in connection with the preparation of a paper on the geology and underground waters of the Coastal Plain of South Carolina. This work was done in cooperation with the State.

Office work.—Arthur Keith completed the Kings Mountain-Gaffney folio.

Publications.—Issued: Bulletin 725-F; press notice, "Pyrite at the Haille mine, Kershaw, S. C."

SOUTH DAKOTA.

Office work.—T. W. Stanton and F. H. Knowlton examined Cretaceous fossils from South Dakota. Sidney Paige made some progress on a report on the Homestake mine.

Publication.—Issued: Press notice, "Oil and gas prospects in the Cedar Creek anticline and vicinity, in Montana, North Dakota, and South Dakota."

TENNESSEE.

Field work.—Oil shales in Tennessee were examined by David White. R. D. Mesler did some field work near Sweetwater, Loudon, and Knoxville. E. F. Burchard made a study of the iron ores of Tennessee in cooperation with the State; he also studied the marble deposits in Lincoln County. W. H. Emmons made further studies in connection with the report on the Ducktown district. G. R. Mansfield visited some bauxite deposits in the State.

Office work.—G. H. Girty continued the study of the faunas of the Fort Payne formation of the Waynesboro quadrangle. W. S. Bayley continued the preparation of his report on the magnetic ores of east Tennessee, in cooperation with the State. T. W. Stanton assembled and revised the manuscript on the Coon Creek fauna, by Bruce Wade. Conferences relating to stratigraphic correlation were carried on between E. O. Ulrich and the State geologist. Mr. Ulrich also made studies of paleontologic material from the State. R. D. Mesler continued work on the faunas of the Athens shale and the Whitesburg limestone. G. W. Stose revised a manuscript of a report on the manganese deposits of eastern Tennessee, to be published by the State Survey. A brief report on the Tennessee marble areas mapped during the season of 1920-21 was prepared by K. K. Kimball.

Publication.—In press: "Manganese deposits of east Tennessee," by G. W. Stose and F. C. Schrader (Bulletin 737).

TEXAS.

Field work.—N. M. Fenneman made physiographic studies in Texas. D. D. Christner continued the inspection of wells in progress of drilling and gathered samples of salt brines in connection with potash studies. Later in the year this work was taken over by H. W. Hoots. J. A. Gardner continued to study the Eocene of Texas. L. W. Stephenson continued field work in connection with a report on the Cretaceous stratigraphy of Texas between San Antonio and the Rio Grande. A. C. Trowbridge made field studies in connection with the Tertiary geology of southern Texas.

Office work.—M. I. Goldman examined samples of cap rock from salt domes and prepared a short paper on such domes. A report by C. E. Dobbin on the Wiles area, in Stephens County, was submitted for publication. A report on the Ranger oil field was revised by Frank Reeves. L. B. Pusey prepared the oil and gas map of Texas, under the supervision of G. B. Richardson and K. C. Heald. A manuscript by Sidney Powers and O. B. Hopkins, on the Brooks, Steen, and Grand Saline salt domes, in Smith and Van Zandt counties, was transmitted for publication. A preliminary report on the Rio Grande region of Texas was submitted by A. C. Trowbridge. A report on the flora of the Woodbine sandstone at Arthurs Bluff was completed by E. W. Berry. T. W. Stanton reported on Comanche invertebrates from this State. L. W. Stephenson prepared a press notice on the geologic features near Del Rio, in Val Verde and Kinney counties. M. R. Campbell revised a paper by Alexander Deussen on the Coastal Plain of Texas.

Publications.—Issued: Prof. Paper 129-G; Bulletins 726-G, 736-A; press notices, "Risks great in oil fields of north-central Texas," "Anticlinal fold near Del Rio, Tex.," "Stock promotion and potash in west Texas," "Extension of possible potash area in western Texas," "Potash in new area of Texas." In press: "Geology of the Coastal Plain region of Texas," by Alexander Deussen (Prof. Paper 126); "Physiographic provinces and sections in western Oklahoma and adjacent parts of Texas," by N. M. Fenneman (Bulletin 730-D); "Geology of the Wiles area, Ranger district, Tex.," by C. E. Dobbin (Bulletin 736-C); "Geology of the Ranger oil field, Tex.," by Frank Reeves (Bul-

letin 736-E); "The Brooks, Steen, and Grand Saline salt domes, Smith and Van Zandt counties, Tex.," by Sidney Powers and O. B. Hopkins (Bulletin 736-G).

UTAH.

Field work.—Work in Kane and Garfield counties, Utah, with particular reference to oil and gas possibilities, was carried on by R. C. Moore, assisted by P. C. Benedict and A. C. Tester. Mr. Moore also studied the oil value of lands in southern Wayne County and examined the coal territory in the Paunsaugunt Plateau, for the land-classification board. The asphalt deposits at Rozel Point, at the north end of Great Salt Lake, was visited by K. C. Heald. E. M. Spieker, assisted by W. B. Upton, Jr., and W. W. Boyer, made geologic studies with reference to coal in Carbon County. F. C. Calkin carried on detailed geologic mapping in an area north and south of Big Cottonwood Creek. C. B. Longwell and Kirk Bryan continued geologic studies of Colorado River in connection with power-site investigations. J. D. Sears studied the coal lands near Vernal for the land-classification board. M. R. Campbell spent a short time in the Castlegate coal field. H. D. Miser studied the geology along the lower course of San Juan River and along Colorado River in Glen Canyon, Utah and Arizona. Sidney Paige made geologic studies along Colorado River between Green River, Utah, and Lees Ferry, Ariz., in connection with power-site surveys.

Office work.—R. C. Moore prepared a report on Kane and Garfield counties and submitted a short paper discussing oil prospects in the Circle Cliffs anticline, for issue as a press bulletin. A report on the coal and oil values of lands in southern Wayne County was submitted to the land-classification board by Mr. Moore. Work on a report on oil shale in the Rocky Mountain region, by Dean E. Winchester, was completed by K. C. Heald. H. D. Miser prepared a press bulletin on the stratigraphy of southern Utah. F. L. Hess wrote a report on the radium deposits of Temple Mountain and Salt Lake City and a paper on the molybdenum deposits at Ouray. G. H. Girty prepared a paper as the result of the study of collections of fossils from this State. A paper on the Rainbow Bridge is in preparation by H. D. Miser, K. W. Trimble, and Sidney Paige.

Publications.—Issued: Prof. Paper 129-D; Bulletins 725-C, 726-C; press notices, "Coal resources of the Wasatch Plateau, Utah," "Possible oil in southern Utah," "Geologic work in southeastern Utah." In press: "Guidebook of the western United States, Part E—The Denver & Rio Grande Western Route," by M. R. Campbell (Bulletin 707).

VERMONT.

Field work.—A. C. Swinnerton continued detailed studies of the Castleton quadrangle, Vt., under the direction of Arthur Keith. Mr. Keith studied the stratigraphy and structure of northwestern Vermont. L. M. Prindle continued studies of the Hoosick and Bennington quadrangles.

Office work.—Arthur Keith prepared a paper on the Cambrian succession of northwestern Vermont.

VIRGINIA.

Field work.—G. W. Stose and Charles Butts made stratigraphic studies in the Big Stone Gap area. C. K. Wentworth studied the terrace gravels of Virginia. M. R. Campbell and C. E. Dobbin examined certain proposed forest reserves in this State. Mr. Campbell also made geologic studies in the vicinity of Orkney Springs. Arthur Keith prepared a report on the proposed Whitetop National Forest for the Forest Service. W. C. Mansfield collected fossils and made stratigraphic studies in the vicinity of Yorktown, Suffolk, and Smithfield.

Office work.—Work on a coal report on Wise County was continued by J. B. Eby. Stratigraphic and paleontologic investigations were made by E. O. Ulrich and G. W. Stose. Mr. Ulrich studied collections of fossils obtained near Salem. M. R. Campbell revised a paper on the Lee County coal field. R. D. Mesler continued paleontologic work on the Athens fauna and the Whitesburg limestone. J. A. Gardner continued paleontologic studies for a report on the Pliocene and Miocene of Virginia and North Carolina.

Publications.—Issued: Press notices, "Possible coal mining in a new field on lower Guest River, Va.," "The Endless Caverns at New Market, Va."

WASHINGTON.

Field work.—J. T. Pardee made a study of the Pleistocene geology in the neighborhood of the Spokane River valley, in eastern Washington. F. C. Calkins investigated supposed oil seeps at Spokane for the Department of Justice.

Office work.—W. H. Dall reported on Pleistocene fossils from Puget Sound and identified certain Tertiary and Eocene fossils from the Olympic Peninsula.

Publications.—Issued: Bulletins 725-A, 725-C.

WEST VIRGINIA.

Office work.—G. H. Girty prepared a paper on the upper Mississippian fauna of West Virginia.

WISCONSIN.

Office work.—E. O. Ulrich studied some of the Cambrian formations of Wisconsin.

WYOMING.

Field work.—The oil-bearing strata of Wyoming were examined by W. T. Lee and J. B. Reeside, jr., assisted by H. S. Cave, Quentin D. Singewald, and R. Lee Collins. A sketch map of the Bolton Creek district was prepared by M. G. Gulley. The Beaver Valley anticline, in Weston County, was examined by M. N. Bramlette. The Teapot dome, in Natrona County, was visited by K. C. Heald to study its geology and probable productivity. Oil fields in eastern Wyoming were visited by C. D. Avery. Data for revision and completion of the geologic map of Wyoming were collected in Denver, Casper, and Laramie by J. D. Sears. M. R. Campbell spent some time in the examination of the Rock River coal field. C. R. Longwell and assistants began the study of the Black Hills rim, in northern Wyoming, with relation to the occurrence of structure favorable for oil.

Office work.—D. F. Hewett continued the preparation of a report on the geology and mineral resources of the Meeteetse and Grass Creek quadrangles. T. W. Stanton examined fossils from the Cretaceous of this State. F. H. Knowlton continued preparation of a report on the Green River flora. G. R. Mansfield prepared classification data of phosphate lands for the land-classification board. G. H. Girty examined collections of fossils from this State. J. B. Reeside, jr., revised a report on the fauna of the Dakota formation. A report on the Lost Soldier-Ferris district was prepared by A. E. Fath and Gail F. Moulton. An article on the age of the domes and anticlines in this district, prepared by Mr. Fath, was published in the *Journal of Geology*. The oil and gas map of Wyoming was compiled by L. B. Pusey under the supervision of G. B. Richardson and K. C. Heald. A report describing the Beaver Valley anticline, in Weston County, was prepared by M. N. Bramlette and transmitted to the land-classification board. An oral report on the Teapot dome was made to the Secretary of the Interior, and a memorandum furnishing bases for conclusions was transmitted to the Director of the Survey. A report on the Osage oil field, Weston County, was completed by A. J. Collier. Data for use in preparing a structure contour map of northeastern Wyoming were collected by W. T. Thom, jr. James Gilluly drew a structure contour map of the Kirby Creek district, Hot Springs County, under the direction of K. C. Heald. The structure map of the Rock Creek oil field, by E. T. Hancock, was revised by Mr. Gilluly under the supervision of Mr. Heald. A statement regarding the stratigraphy, structure, and oil possibilities of Hanna Basin, based upon field work by C. F. Bowen, was prepared by Mr. Heald for issue as a press bulletin. A paper on the oil-bearing strata of Wyoming was transmitted for publication in "Contributions to economic geology." A second paper discussing stratigraphy of a separate group was nearly completed.

Publications.—Issued: Press notice, "Coal and oil resources of the Hanna Basin, Carbon County, Wyo." In press: "The Osage oil field, Weston County, Wyo." by A. J. Collier (Bulletin 736-C).

HAITI.

A report on a reconnaissance of the geology, mineral resources, and water resources of the Republic of Haiti is in preparation by W. P. Woodring, J. S.

Brown, and W. S. Burbank. The field work was done in compliance with a request from the civil authorities of the Republic and was begun September 21, 1920.

OTHER COUNTRIES.

Through cooperation with governmental and scientific institutions a number of members of the geologic staff, especially the paleontologists, have been called on for special examinations or determinations relating to the faunas and geology of Hawaii, Iceland, Canada, Peru, the Philippine Islands, Argentina, Colombia, Bolivia, Java, the Pacific islands, Mexico, New Zealand, and Cuba.

GENERAL PUBLICATIONS.

In addition to the publications listed above under the individual States the following publications of more general scope were prepared in the division of geology:

Issued: Prof. Papers 128, 129-B, 129-C, 129-F; Bulletins 679, 715, 716, 725-D; press notice, "The oil supply of the United States."

In press: "Coal fields of the United States—general introduction" (revised), by M. R. Campbell (Prof. Paper 100-A); "Shorter contributions to general geology, 1921" (Prof. Paper 129); "Additions to the flora of the Wilcox group," by E. W. Berry (Prof. Paper 131-A); "High-grade clays of the eastern United States," by H. Ries, W. S. Bayley, and others (Bulletin 708); "Contributions to economic geology, 1921," Parts I and II (Bulletins 725 and 726); "The occurrence and uses of peat in the United States," by E. K. Soper and C. C. Osborn (Bulletin 728); "Oil shale of the Rocky Mountain region," by D. E. Winchester (Bulletin 729); "The shapes of pebbles," papers by C. K. Wentworth (Bulletin 730-C); "The commercial granites of New England," by T. N. Dale (Bulletin 738); "Mica deposits of the United States," by D. B. Sterrett (Bulletin 740).

DIVISION OF MINERAL RESOURCES.

The organization of the division of mineral resources was described in the last annual report. During the year the division was depleted by nine resignations and two deaths. R. W. Stone, chief of the non-metals section and administrative assistant, resigned January 1, and his place was not filled until April 1, when F. J. Katz returned from a 2½ years' furlough to the Bureau of the Census. During May and June Mr. Katz acted in charge of the division, relieving Mr. Loughlin, who resumed his geologic work.

An outstanding feature of the work of the division during the year was a reduction of the force without appreciable decrease in the service rendered. This reduction, already planned to take effect as soon as delayed work was caught up, was hastened by unexpected resignations. The work on mineral fuels, however, was so far behind that the funds released by resignations were necessarily used in part to engage temporary help to complete this work. It is confidently expected that the annual reports on fuels for 1921 will be completed quite as promptly as those for the years preceding the war.

The experience in completing these reports emphasizes the desirability of engaging temporary clerks from January to June to expedite the routine work that has hitherto delayed the completion of the longer reports. It is hoped that this plan can be followed every year, and that there will still remain more funds than formerly for conducting field work, which has necessarily been neglected during the last few years. Even with the present reduced force the total appropriation is inadequate for the work that should be done by the division.

The failure to obtain properly qualified specialists to give at least a part of their time to the work of this division still leaves 11 subjects to be cared for without adequate supervision. The annual reports on these subjects have been again prepared by the more experienced statistical clerks, who deserve much credit for their work; but the standard of these reports, including the collection of general information relating to these subjects, can not be maintained indefinitely without the supervision of specialists. During the war, when the number of specialists employed was largest, a great deal of information was made available. Since then much of the work on nonmetals other than fuels has been "drifting on its momentum." Owing to the general business depression that has prevailed the shortage of specialists has not been seriously felt until recently; but during the last few months resumption of activity by mineral producers and consumers has brought an increasing number of inquiries for technical information, and if the division is to maintain the quality of its work, specialists who can devote a part of their time to the division of mineral resources and part to the division of geology must be obtained.

The work on fuels continued to excite the most public interest, and special timely reports were issued as each situation arose. Reports on consumers' stocks of coal were prepared in cooperation with the Bureau of the Census. The work on other nonmetals and metals continued as usual, but without any very striking features, owing to the depressed state of most of the mineral industries.

On January 1 cooperation with the Bureau of the Census was resumed in the collection of statistics on such subjects as that bureau had to cover in its biennial census of manufactures. The present arrangement is a great improvement over previous arrangements and has caused very little delay or inconvenience to either bureau. It is so evident, however, that the two bureaus have different objectives in view that it is doubtful if the attempt to avoid duplication in the canvass of producers reduces the amount of labor. The two bureaus assist each other gladly whenever possible, but any attempt of one bureau to collect statistics in which only the other bureau is interested is necessarily cumbersome.

Cordial cooperation with the State geological surveys continued, and the number of cooperating States increased from 17 to 18.

In January, for the first time since the three western offices were established in 1905, the statisticians in charge of them assembled in Washington for a conference on the work of the division. The conference was very successful and helpful to all concerned and brought the western and home offices in much closer touch than ever before. The scope of work in the western offices continues to grow in all branches of the mineral industry, and much service has been rendered by these offices in collecting data for the weekly and monthly reports on fuels. The demands on these offices during the year have again emphasized the need of a resident geologist at each office, but circumstances have prevented the assignment of geologists to the offices in Denver and Salt Lake City.

The section of foreign mineral reserves continued to supply timely information, especially on oil, and added to its files of information on foreign geology and mineral statistics. Owing to the shortage of specialists, practically no headway was made with the part of the

World Atlas that is to show the mineral reserves of Europe and Latin America.

Progress in completion of the annual chapters for Mineral Resources of the United States has been very encouraging. The final installments of the long-delayed volume for 1919 were sent to the printer in March and May, and by the end of June 32 chapters of the volume for 1921 had been transmitted. Those still incomplete involve the handling of a large number of producers' reports and can not be completed earlier, unless all producers return their statements much earlier in the year and the clerical force is temporarily enlarged to expedite the office work. The preliminary summary of mineral production in 1921 was transmitted on April 1 and was published on September 14, 1922, whereas the corresponding summary for 1920 was published on July 7, 1921. Extra payment for expediting the printing of the summary for 1921 was not permitted, and this accounts for the difference in dates of publication.

All the reports for 1921 have been much curtailed, primarily to keep within the reduced printing fund, and also because the scope of most of the reports has become so stabilized that much of the discussion of statistical tables is no longer necessary. The number of copies printed for free distribution has also been reduced.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

The work of the division of chemical and physical research comprised researches relating to geologic processes, complete and partial analyses of rocks, minerals, and ores, and the identification and study of minerals. George Steiger, chief chemist, supervised the work in chemistry and acted in charge of the division, and C. E. Van Orstrand directed the work in physics.

The available funds were \$3,000 for one chemist and a lump-sum appropriation of \$40,000 for laboratory expenses and salaries of chemists, physicists, and helpers. Of the lump sum, \$6,860 was allotted for field expenses in the search for potash. The personnel of the division consisted of 7 chemists, 2 physicists, 2 laboratory aids, 1 clerk, 1 laboratory assistant, and 1 laborer. The privileges of the laboratory were temporarily extended to Miss Taisia Stadnichenko, who has been engaged in some studies of oil shale with David White.

WORK IN CHEMISTRY.

During the year 1,720 quantitative analyses were made, mainly for use in geologic investigations, and in addition 2,206 specimens were qualitatively tested, most of them for persons not officially connected with the Survey. A large number of minerals were also identified.

Laboratory experiments on the effect of nitric acid on certain granites were concluded by George Steiger, and the data were prepared for publication. A long series of analyses of waters of Chesapeake Bay was made by E. P. Henderson, and the results are being prepared for publication by R. C. Wells. Another long series of analyses of ocean-bottom samples was made by J. G. Fairchild, and the results will be used in a geologic investigation by T. W. Vaughan. Each of these series of analyses is the most complete ever made in its particular class.

The carbon dioxide content of sea water at Tortugas, Fla.; the alkalinity of Searles Lake brine; the water of Borax Lake; and experiments on the accurate determination of silica were some of the studies occupying the time of Mr. Wells, who prepared papers on each except the first. Mr. Wells also wrote the chapter on sodium compounds, 1920, for Mineral Resources and prepared a report on physical and chemical investigations of sediments for the division of geology of the National Research Council. Toward the end of the year he started an elaborate study of the formation of the Lake Superior copper ores.

Two new minerals were analyzed and their physical properties determined, the names gillespite and sincosite were given to them, and articles describing them by W. T. Schaller were published in the Journal of the Washington Academy of Sciences.

Uranium and vanadium minerals were studied in detail, and analytical methods for the determination of vanadium and selenium were tested by Mr. Schaller, who also studied the rare minerals mordenite, vegasite, autunite, carnotite, melanovanadite, hydroboracite, ludlamite, serendibite, and tschermigite, checking their predetermined optical properties and, for some of them, determining properties which had not heretofore been described.

An interesting study of organic compounds as they exist in oil shale before being changed by heat was conducted in collaboration with Mr. White and Miss Stadnichenko by E. T. Erickson, who prepared an article on the detection of small quantities of petroleum that was published in the Engineering and Mining Journal. The first reported occurrence of tschermigite in this country was described by Mr. Erickson. Associated with the tschermigite was a small quantity of a new variety of jarosite containing ammonia.

An article containing some original ideas on the evolution of matter, by F. W. Clarke, was published in the Journal of the Washington Academy of Sciences. Mr. Clarke completed a manuscript on the composition of river and lake waters of the United States and partly prepared a more complete paper on the evolution of matter.

An elaborate report on the composition of the earth's crust, by Mr. Clarke and Henry S. Washington, of the Carnegie Geophysical Laboratory, was transmitted for publication as a professional paper.

The search for potash in natural salts continued to yield promising results. The field work is described in the report of the division of geology. Several hundred samples of salts were collected by the Survey's field representatives in western Texas and were assayed by R. K. Bailey. Potash was found in varying quantities in samples from 15 different wells distributed over an area of several hundred square miles. Some of the samples contained more than 11 per cent of potash, and in a number of these wells one or more zones of salts containing workable percentages of potash were encountered. The wells were being drilled for oil, not for potash, and the samples were not taken in a way to show the thickness of the layers of potash-rich salt. A number of core-drilled wells are in prospect within this area, and more definite information is expected in the near future. A new field test for polyhalite, the principal potash

mineral occurring in the salts so far obtained, was devised by Mr. Steiger and published, together with other tests and a method for assay, in a special press notice. An article on the potash salts of western Texas, by Mr. Steiger, was published in *Chemical and Metallurgical Engineering*.

WORK IN PHYSICS.

Work in the physical laboratory included theoretical and experimental investigations in both field and laboratory by C. E. Van Orstrand on the general subject of deep earth temperatures. Observations of temperatures in deep wells were made in North Dakota, Oregon, Washington, California, Colorado, and Illinois. Mr. Van Orstrand also continued the reduction of the temperature data for the entire globe, which is nearly completed, and the development of apparatus for making temperature tests in deep wells by means of mercury thermometers, which has been carried to such a point that a geothermal survey can be conducted with reasonable efficiency and a high degree of accuracy. Some temperature curves for a cooling sphere were evaluated for incorporation in the volume on the probability integral. A short paper by Mr. Van Orstrand and M. A. Shoultes on the values of the sine and cosine to 33 places of decimals for various values of the argument expressed in seconds is ready for publication.

The pore space in 142 samples of oil sand and the diameter of grains of 10 samples were determined by A. F. Melcher and J. G. Douglas. Apparatus for determinations of permeability and absorption in oil and gas sands has been completed, and some preliminary tests have been made. Attention was given to a microscopic examination of oil sands for the purpose of obtaining information in regard to shape of pores, location of cement, and other significant features. A field study of the oil sand in the Burbank field, Osage County, Okla., was made by Mr. Melcher, who also wrote for the *Bulletin of the American Association of Petroleum Geologists* a note on the permeability and absorption of sands for oil, water, and gas with reference to their normal and possible yield.

Mr. Shoultes assisted in all the experimental work of the laboratory and in addition made tests on the diffusion of solids, interpolated values of exponential and trigonometric functions, and reduced observations of deep earth temperatures.

ALASKAN MINERAL RESOURCES BRANCH.

The personnel of the Alaskan force included, on June 30, 1921, 1 geologist in charge, 4 geologists, 2 topographic engineers, 1 draftsman, and 3 clerks on annual salaries, 2 geologists on monthly salaries, and 1 geologist and 1 topographic engineer on per diem salaries; and on June 30, 1922, 1 geologist in charge, 4 geologists, 2 topographic engineers, 1 draftsman, and 3 clerks on annual salaries, 1 geologist on monthly salary, and 3 geologists on per diem salaries.

The funds available, including an appropriation of \$75,000, an unexpended balance of \$13,800, and an allotment of \$12,000 from the appropriation for classification of public lands, were expended as follows:

Estimated distribution of funds for investigations in Alaska, field season 1921.

	1920-21	1921-22
Station, Alaska branch.....		\$5,700
Investigation, mineral resources.....		4,520
Western Alaska.....	\$1,900	7,700
Yukon.....	9,000	11,170
Railroad.....		2,350
Peninsula.....	8,930	9,210
Basin.....	3,340	7,300
Exploration.....		4,660
Collection of mineral statistics.....		1,800
Incidental expenses, including clerical salaries, etc.....	2,630	6,660
Director.....		8,500
Allocated to field work, 1922.....		5,430
	25,800	75,000

Estimated allotments of Alaskan funds to different kinds of surveys and investigations, field season 1921.

	1920-21	1921-22
Station, Alaska branch.....		\$5,700
Geologic and mineral resources investigation.....	\$500	11,900
Dissemination geologic surveys.....	8,820	13,950
Geologic surveys.....	4,200	7,200
Dissemination topographic surveys.....	4,850	4,100
Topographic surveys.....	4,800	5,100
Exploration.....		4,660
Collection of mineral statistics.....		1,800
Incidental expenses, including clerical salaries, etc.....	2,630	6,660
Director.....		8,500
Allocated to field work, 1922.....		5,430
	25,800	75,000

Estimated disbursements of Alaskan funds for salaries and field expenses, field season 1921.

	1920-21	1921-22
Salaries.....	\$500	\$30,400
Incidental expenses.....	22,670	21,340
Incidental expenses, including clerical salaries, etc.....	2,630	9,240
Director.....		8,500
Allocated to field work, 1922.....		5,430
	25,800	75,000

The following table shows the progress of investigations in Alaska during the annual grants of funds since systematic surveys were begun in 1898. A varying amount is spent each year on special investigations that yield results which can not be expressed in terms of money. Since 1918 the reduction of the annual appropriation and increased cost of all field work has not permitted extensive geologic and topographic surveys.

Progress of surveys in Alaska, 1898-1921.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys. ^a					Investigations of water resources.	
		Exploratory (scale 1:325,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:32,500).	Exploratory (scale 1:325,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	Gauging stations maintained part of year.	Stream-volume measurements.
		Sq. m.	Sq. m.	Sq. m.	Sq. m.	Sq. m.	Sq. m.	Miles.			
1898.....	\$46,189	9,500			12,840	2,070					
1899.....	25,000	6,000			8,690						
1900.....	60,000	3,300	6,700		630	11,150					
1901.....	60,000	6,200	5,800		10,200	5,450					
1902.....	60,000	6,950	10,050		8,330	11,970	96				
1903.....	60,000	5,000	8,000	96		15,000					
1904.....	60,000	4,050	3,500		800	6,480	480	86	19		
1905.....	80,000	4,000	4,100	536		4,880	787	202	28		
1906.....	80,000	5,000	4,000	421		13,500	40			14	286
1907.....	80,000	2,600	1,400	442		6,120	501	95	16	48	457
1908.....	80,000	2,000	2,850	604		3,980	427	76	9	53	556
1909.....	90,000	6,100	5,500	450	6,190	5,170	444			61	701
1910.....	90,000		8,635	321		13,815	36			69	429
1911.....	100,000	8,000	10,550	496		14,460	246			68	309
1912.....	90,000		2,000	525			298			69	381
1913.....	100,000	3,500	2,950	180	3,400	2,535	287				
1914.....	100,000	1,000	7,700	325	600	10,300	10				
1915.....	100,000		10,700	200		10,400	12	3	2	9	
1916.....	100,000		5,100	636		9,700	67			20	
1917.....	100,000		1,750	275		1,050				19	
1918.....	77,000		3,500			1,200					
1919.....	75,000		2,700			2,300				19	
1920.....	75,000		1,480			770				19	
1921.....	^b 87,000		2,130	150		300	205				
	1,875,189	73,200	111,095	5,657	51,680	152,600	3,936	462	74		
Percentage of total area of Alaska.....		12.48	18.95	0.96	8.81	26.02	0.67				

^a The Coast and Geodetic Survey, International Boundary Commission, and General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

^b \$12,000 for classification of public lands.

By order of the Director, dated April 1, 1922, the division of Alaskan mineral resources was made the Alaskan mineral resources branch.

Alfred H. Brooks, chief Alaskan geologist, was engaged in office work until August 3 and was absent in Alaska until October 10. He visited Anchorage, Juneau, and the Kantishna and Willow Creek districts. His office time was divided between geologic studies, the annual progress report and press bulletin, field plans, the preparation and delivery of lectures, proof reading, statistics, critical reading and revision of manuscripts, attending scientific meetings, the preparation of an article on the scientist in the Federal service, and administrative and routine matters.

R. H. Sargent made a trip to southeastern Alaska in September 1921, to investigate areas and methods of topographic surveys. In the office he was occupied chiefly in the administration of Alaska topographic surveys and map compilation.

A. F. Buddington was engaged in geologic mapping and investigation of mineral resources of the Wrangell district.

H. M. Eakin, geologist, was employed under contract to complete the report on the geology and mineral resources of Juneau and vicinity.

A detailed geologic and topographic survey of the Iniskin oil field, Cook Inlet, was made under the direction of F. H. Moffit. A. A. Baker assisted in the geologic work, and the topographic surveys were made by C. P. McKinley, assisted by Gerald Fitz Gerald.

Richard K. Lynt was detailed to make reconnaissance topographic surveys in the Cold Bay district. About half of his office time has been devoted to map compilation.

S. R. Capps, assisted by W. R. Smith, was employed in geologic reconnaissance surveys in the Cold Bay district. Mr. Capps also continued the preparation of a report on the geology and mineral resources of the region tributary to the Alaska Railroad. On April 1, 1922, he was furloughed for one year to engage in foreign commercial oil work.

The geologic mapping and study of the mineral resources of the airbanks quadrangle was continued by J. B. Mertie, jr. His office work also included the completion of the long-delayed report on the Uby-Kuskokwim region.

George C. Martin was engaged in studying the geology and mineral resources of the lower Yukon and Koyukuk region. Most of his office time has been devoted to geologic studies of the Alaska Mesozoic formations.

C. Arthur Hollick was employed four and one-half months in continuing his studies on the Alaska Tertiary fossil plants.

James McCormick was employed for about five months in the revision of the "Geographic dictionary of Alaska." John H. Renshaw devoted about one month to the completion of the relief map of Alaska. John B. Torbert has been engaged in Alaska cartographic work throughout the year.

Lack of funds prevented the continuation of stream gaging in northeastern Alaska.

Miss Lucy M. Graves, chief clerk, has continued to carry much of the burden of the administration of the Alaska branch and has acted as chief during the absence of the chief Alaskan geologist and of the senior geologist, G. C. Martin. The details of collecting the statistics of the mineral production of Alaska have been in the hands of T. R. Burch.

The field parties for the season of 1922 are distributed as follows: A. H. Brooks is making general investigations in the coastal regions of Alaska, including some of the Aleutian Islands.

A. F. Buddington is continuing a geologic reconnaissance survey and study of the mineral resources of the Wrangell district.

J. B. Mertie, jr., is extending the geologic reconnaissance surveys and investigations of the mineral resources of a portion of the Yukon-Tanana region.

F. H. Moffit is continuing geologic surveys and a study of the mineral resources of the Chitina region.

R. H. Sargent, assisted by R. K. Lynt, is continuing topographic reconnaissance surveys in the Cold Bay oil field. A. A. Baker and W. R. Smith are attached to this party as geologists.

P. S. Smith is investigating the geology and mineral resources of a part of the region tributary to the Alaska Railroad.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch during the year was as follows:

- Chief topographic engineer, C. H. Birdseye.
- Atlantic division, topographic engineer in charge, Frank Sutton.
- Central division, topographic engineer in charge, W. H. Herron.
- Rocky Mountain division,¹ topographic engineer in charge, T. G. Gerdine.
- Pacific division,¹ topographic engineer in charge, G. B. Davis.
- Division of West Indian surveys, topographic engineer in charge, Glenn S. Smith. (In the absence of Mr. Birdseye, Mr. Smith acted as chief topographic engineer.)
- Computing section, topographic engineer in charge, E. M. Douglas.
- Section of inspection and editing, topographic engineer in charge, W. M. Beaman.
- Section of cartography, draftsman in charge, A. F. Hassan.
- Map information office, topographic engineer in charge, J. H. Wheat.
- Section of relief maps, geographer in charge, J. H. Renshaw.
- Section of photographic mapping, topographic engineer in charge, T. P. Pendleton.²

PERSONNEL.

During the fiscal year one assistant topographic engineer, who had held a commission in the Engineer Officers' Reserve Corps, was reinstated. The technical force was increased by the appointment of 8 junior topographers and the reinstatement and transfer of 2 topographic engineers. The force was reduced by 1 death, 1 retirement, 11 resignations, and 9 transfers. With these changes the corps now includes 1 chief topographic engineer, 4 topographic engineers in charge of divisions, 4 geographers, 75 topographic engineers, 2 topographers, 29 assistant topographic engineers, 35 junior topographers, 1 map editor, 2 map revisers, and 8 draftsmen, a total of 161. During the year 10 topographic engineers, 8 assistant topographic engineers, and 34 junior topographers were on furlough. One topographic engineer in charge of a division and 4 members of the permanent force were on furlough during the year for work in Porto Rico. In addition, 30 technical field assistants were employed during the whole or a part of the year. The clerical force comprises 10 clerks of various grades.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consists of 70 new standard topographic maps and 6 new State maps; 4 new State maps are in press. Advance photolithographic editions were printed for 66 new topographic maps now in process of engraving and final publication; and 32 photolithographs were printed of new topographic maps, for which publication has not yet been otherwise provided. A map of Camp A. A. Humphreys and vicinity, Virginia, was printed for the War Department.

¹ On the death of G. R. Davis, T. G. Gerdine was appointed topographic engineer in charge of the Pacific division and Glenn S. Smith was appointed topographic engineer in charge of the Rocky Mountain division. At this time the State of Washington was added to the Pacific division and the State of Mississippi to the Rocky Mountain division.

² T. P. Pendleton was on leave without pay from Apr. 16 to the end of the fiscal year, and during that time J. H. Wheat was in charge of the section.

Seven additional advance chapters of Bulletin 709, giving the results of triangulation and primary traverse for 1916-1918, prepared for publication in 1920, are still in press. Sufficient manuscript is now on hand, awaiting funds for publication, for 30 or more bulletins on spirit leveling, primary traverse, and triangulation, covering work for several years, in more than 35 States.

New features introduced during the year were (1) the classification of roads as to through and secondary routes and the representation of this classification on the topographic maps by a red overprint, (2) the preparation of plan and profile drawings of the special river surveys for reproduction and sale as three-color photolithographs.

APPROPRIATIONS.

The Federal appropriations for topographic surveys for the fiscal year 1922 were as follows:

Topographic surveys.....	\$330,000.00
Salaries, scientific assistants.....	9,200.00
Special funds for military mapping (contributed by War Department).....	14,321.72
	<hr/> 353,521.72

Practically all of these appropriations were expended during the fiscal year.

COOPERATION.

Cooperation has been maintained in 20 States and 1 Territory, which contributed the following amounts:

California.....	\$13,001.85	South Dakota.....	\$1,960.79
Hawaii.....	24,259.11	Tennessee.....	6,049.51
Idaho.....	2,712.25	Texas.....	9,459.46
Illinois.....	39,756.63	Utah.....	118.22
Iowa.....	1,239.20	Vermont.....	2,990.47
Kentucky.....	9,726.81	Virginia.....	7,071.01
Maine.....	5,676.45	Washington.....	8,421.67
Mississippi.....	4,377.98	West Virginia.....	19,860.21
Missouri.....	15,556.39	Wisconsin.....	11,840.22
New York.....	15,000.00		
Oregon.....	5,553.81		<hr/> 223,416.44
Pennsylvania.....	18,784.40		

In addition, repay work was executed as follows: For the land-classification board, work on base maps needed in the classification of lands and power sites, entailing the expenditure of \$27,080.76, and in this connection the Southern California Edison Co. cooperated with the Geological Survey on surveys of Colorado River in Utah and Arizona, expending \$36,479.39 for work supervised by the Geological Survey; work for the Reclamation Service cost \$15,804.45, the larger part of which was made available to the Reclamation Service by the Klamath-Shasta Valley Irrigation District, and in this connection the State of California expended \$6,324.59; work for the National Park Service cost \$4,269.47; base-map work for the Bureau of Education, \$124.85; base-map work for the Bureau of Public Roads, \$9,817.66; base-map work for the Forest Service, \$976.57; field surveys for the Navy Department, \$328.39; base-map work for the State Department, \$1,423.67; and work for the War Department on the special military map of Camp A. A. Humphreys,

Va., \$716.71. The total amount available from these sources was \$103,346.51.

The total amount expended from all sources for the work of the topographic branch was \$680,284.67.

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1922, distinguished as to scale and date, is shown on Plate I.

As shown in the following table, the new area mapped was 11,402 square miles, making the total area surveyed to date in continental United States, exclusive of Alaska, 1,218,912 square miles, or 40.2 per cent of the entire country. In addition, 1,487 square miles of re-survey was completed, making the total area of surveys during the year 12,889 square miles. River surveys amounting to 455 linear miles were also made.

In connection with these surveys, 3,035 linear miles of primary levels were run, making 290,781 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 811 permanent bench marks were established.

Triangulation stations to the number of 73 were occupied and 64 were permanently marked.

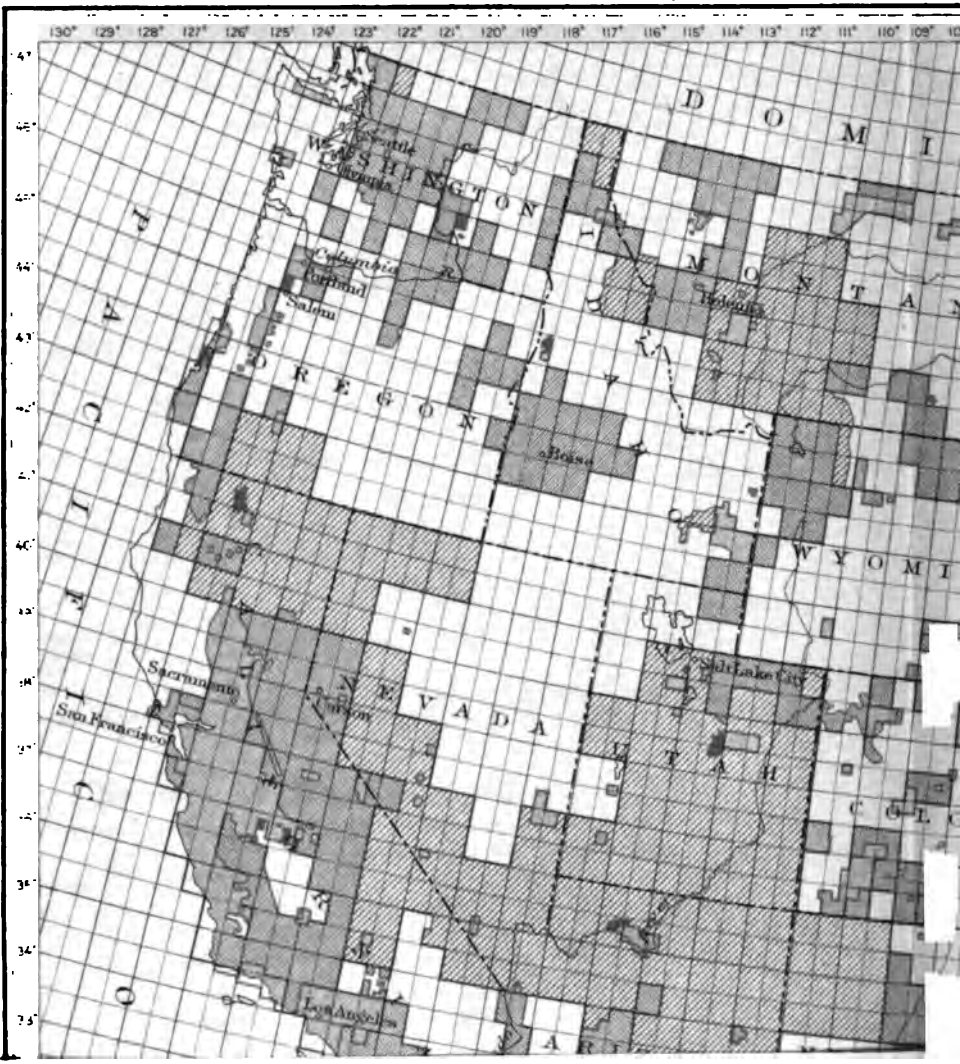
Primary traverse lines aggregating 2,225 miles were run, in connection with which 483 permanent marks were set.

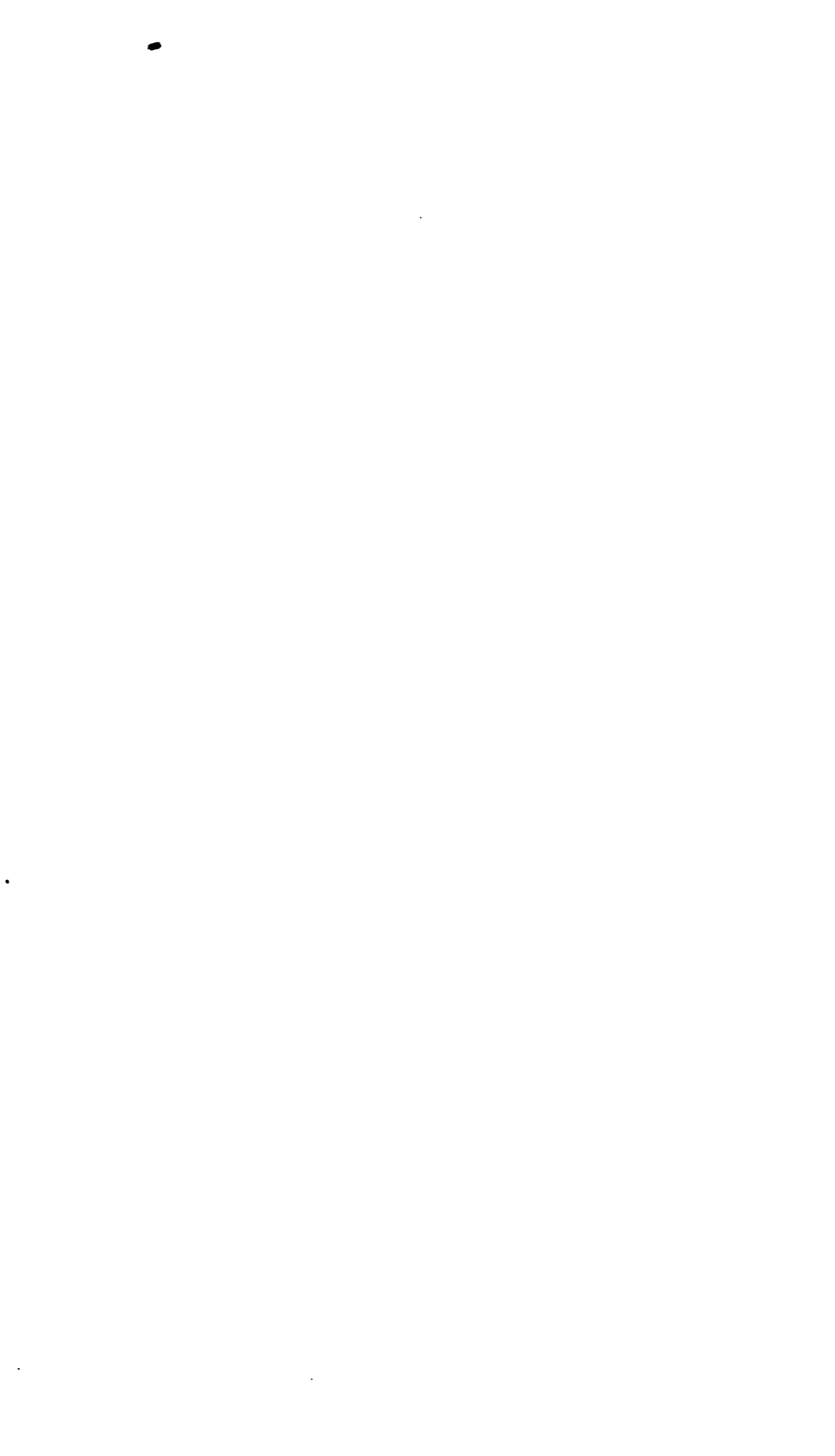
In addition, 655 square miles of topographic mapping was completed in Hawaii, 201 miles of primary levels were run, 63 permanent bench marks established, and 16 triangulation stations were occupied and 12 marked.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1921, to June 30, 1922.^a

State.	New area mapped July 1, 1921, to June 30, 1922.	Total area mapped to June 30, 1922.	Percentage of total area of State mapped to June 30, 1922.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	
Alabama.....		19,192	37.0
Arizona.....	843	55,429	48.7
Arkansas.....		21,494	40.3
California.....	861	120,062	76.1
Colorado.....		51,134	49.3
Connecticut.....		4,965	100.0
Delaware.....		2,370	100.0
District of Columbia.....		70	100.0
Florida.....		4,716	8.0
Georgia.....		24,835	41.9
Idaho.....	82	28,572	33.8
Illinois.....	1,998	20,414	36.0
Indiana.....		3,609	10.0
Iowa.....	116	12,386	22.0
Kansas.....		64,159	78.0
Kentucky.....	419	19,197	47.2
Louisiana.....		8,366	17.2
Maine.....	365	10,844	32.6
Maryland.....		12,327	100.0
Massachusetts.....		8,266	100.0

^a This table differs from those in previous annual reports in that it has been revised to eliminate areas in Montana, Utah, Arizona, New Mexico, Nevada, and California covered by reconnaissance surveys made by the Powell, Wheeler, Hayden, King, and Northern Transcontinental surveys. Of the areas included in the table fully 50 per cent were covered by maps that are now in need of thorough revision.





Present condition of topographic surveys, etc.—Continued.

State.	New area mapped July 1, 1921, to June 30, 1922.	Total area mapped to June 30, 1922.	Percentage of total area of State mapped to June 30, 1922.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	
Ala.		11,153	19.2
Ariz.		7,354	8.7
Ark.	622	3,762	8.0
Cal.	1,220	38,614	55.6
Col.		41,590	28.5
Conn.		27,117	35.0
Del.		41,141	37.5
Fla.		4,235	45.3
Ill.		8,224	100.0
Ind.		40,412	32.9
Iowa.	733	46,734	94.9
Kan.		18,876	36.0
Kent.		10,017	14.1
La.		41,040	100.0
Mass.		39,908	57.0
Mich.	316	25,904	26.7
Minn.	1,031	28,927	64.1
Mo.		1,248	100.0
Mont.		13,675	44.1
Nebr.	77	19,109	24.6
Nev.	137	21,420	50.9
N.H.	449	77,313	29.0
N.J.	659	16,302	19.2
N.M.	361	5,290	55.3
N.Y.	214	36,272	85.0
Ohio.	414	32,004	46.2
Ore.		24,170	100.0
Penn.	485	14,606	28.0
R.I.		30,088	30.7
S.D.			
Tenn.			
Tex.			
Vt.			
Wash.			
W. Va.			
Wis.			
Wyom.			
Al continental United States (exclusive of Alaska)	11,402	1,218,912	40.2
	655	2,416	37.4

Topographic surveys from July 1, 1921, to June 30, 1922.

State.	Contour interval.	For publication on scale of—				Total area surveyed.		
		1 : 24,000	1 : 31,680	1 : 62,500	1 : 125,000	New.	Resurvey.	Total.
		<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
Ala.	25, 50		60	779		839		839
	5, 25	298	563			861		861
	50			82		82		82
	10, 20			1,998		1,998		1,998
	10			116		116		116
	20			419		419		419
	20			365		365		365
Ariz.	20			622		622		622
	20			1,220		1,220		1,220
	20			733		733		733
	25, 50			316		316		316
Ark.	20			1,031		1,031		1,031
	20			77		77		77
	20			137		137		137
	5	3	356	90		449		449
	5, 20, 50		663			663		663
	20			361		361		361
	20			214		214		214
Cal.	25, 100			222	192	414		414
	50			1,487			1,487	1,487
	10, 20	36		449		485		485
		337	1,642	10,718	192	11,402	1,487	12,889
			655			655		655

Topographic surveys from July 1, 1921, to June 30, 1922—Continued.

State.	Levels.		Primary traverse.		Triangulation.	
	Distance run.	Perma- nent bench marks.	Distance run.	Perma- nent marks.	Stations occupied.	Stations marked.
	<i>Miles.</i>		<i>Miles.</i>			
Arizona.....	41	13				
California.....	109	25	30	7	38	31
Idaho.....	51	14			19	23
Illinois.....	764	195	741	178		
Kentucky.....	66	20	3			
Maine.....	8	2				
Mississippi.....	18					
Missouri.....	428	110	251	56		
New York.....	85	25	113	10		
Pennsylvania.....	332	81	185	1		
South Dakota.....	79	17				
Tennessee.....	93	33	166	20		
Texas.....	72	31	99	34		
Vermont.....	84	19				
Virginia.....	34	9	140	42		
Washington.....	32					
West Virginia.....	498	143			16	10
Wisconsin.....	241	74	527	135		
	3,035	811	2,225	483	73	64
Hawaii.....	201	63			16	12

GENERAL OFFICE WORK.

Computations for vertical and horizontal control were made, and the results were copied and cataloged by the computing section. The section of relief maps prepared shaded relief maps of Alaska, California, Kentucky, and southwestern Arizona, as well as relief maps of the following quadrangles: Seven Devils, Idaho; Howard, Lockhaven, and Williamsport, Pa.; Monument Springs, Tex.; and Washington, D. C., and vicinity. In addition, relief maps were prepared of the area adjacent to the Denver & Rio Grande Western Railroad for illustrations to accompany the Guidebook of the Western United States, Part E. The section of photographic mapping was engaged in miscellaneous work in connection with the utilization of Air Service photographs in topographic mapping. The map information office was engaged in indexing and cataloging the map data available in the several Federal departments and in furnishing miscellaneous map information to the public.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

The section of inspection and editing of topographic maps continued to supervise the office preparation of all field topographic maps and to inspect and edit them before reproduction; it also edited a large number of maps submitted by other Survey branches and Government bureaus.

The number of Survey topographic maps in progress in the topographic branch (exclusive of those being engraved and printed) ranged from 103 in August to 151 in April; the monthly average was 133. An average of 15 employees were engaged in this section for the year.

James McCormick employed one-third of his time as the Survey representative on the United States Geographic Board and on similar special investigations and nearly one-half of the year on a revision of the Geographic Dictionary of Alaska.

The work of the section is described further under "Publication branch" (p. 74).

SECTION OF CARTOGRAPHY.

The compilation of the base of the United States portion of the international map of the world was continued during the year, with the cooperation of the Bureau of Public Roads. The Maine, Kansas, and Colorado portions of this map, in course of compilation the previous year, were completed, and the Texas portion of this map, also partly compiled the previous year, was 98 per cent completed. Preliminary maps based on the State maps of the General Land Office were also compiled for Louisiana, Oklahoma, Utah, Nevada, and New Mexico. The map of North Carolina was partly revised, and the eastern two-thirds of the map of Montana was completely revised. Maps of this series have been prepared for 46 States.

Other map projects included the preparation of a map of China and adjacent regions for the Department of State in connection with the Conference on Limitation of Armament; a map of Benton County, Tenn., in cooperation with that State; compilation of road data in cooperation with the State of Illinois; road maps of New York, Indiana, and Missouri for the Bureau of Public Roads; and several maps for the Brazilian exhibit of the Federal Board for Vocational Education.

ATLANTIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Maine, Mississippi, New York, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia. This work comprised the completion of the survey of 17 quadrangles and 1 special area and the resurvey of 5 quadrangles, in addition to which 12 quadrangles were partly surveyed and 8 were partly resurveyed. Triangulation and primary traverse were carried on by nine parties in New York, Pennsylvania, Tennessee, Virginia, and West Virginia.

Maine.—In cooperation with the Maine State Water Power Commission the survey of the Brassua Lake and Farmington quadrangles was completed and that of the Long Pond quadrangle was begun, the total area mapped being 365 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Long Pond quadrangle 8 miles of primary levels were run and 2 permanent bench marks established.

Mississippi.—In cooperation with the Mississippi Geological Survey the survey of the Meridian, Morton, and Tupelo quadrangles was completed, and that of the Pelahatchee quadrangle was begun, the total area mapped being 622 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Morton and Pelahatchee quadrangles 18 miles of primary levels were run.

New York.—In cooperation with the State engineer of New York, the survey of the Cattaraugus, Livingston Manor, Santa Clara, and Stark quadrangles was completed, and that of the Red House quadrangle was begun, the total area mapped being 733 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Cattaraugus, Red House, and Santa Clara quadrangles 85 miles of primary levels were run and 25 permanent bench marks were established. For the control of the Cattaraugus and Red House quadrangles 113 miles of primary traverse were run and 10 permanent marks set.

At the request of the Bureau of Yards and Docks, Navy Department, a proposed hospital site for the Veterans' Bureau, near Liberty, N. Y., was surveyed. The cost of the work, amounting to \$328.39, was paid by the Navy Department.

Pennsylvania.—In cooperation with the Pennsylvania State Bureau of Topographic and Geological Survey, the survey of the Howard, Lock Haven, Pocono, Shippensburg, Tyrone, and Williamsport quadrangles was completed and that of the Mauch Chunk, Mount Union, and Milton quadrangles was begun, the total area mapped being 1,031 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For control for new work 332 miles of primary levels were run, 81 permanent bench marks established, 155 miles of primary traverse were run, and 1 permanent mark set.

Tennessee.—In cooperation with the Tennessee State geologist, the survey of the Lillydale and Reelfoot Lake quadrangles was begun, the total area mapped being 137 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For control for new work 93 miles of primary levels were run, 33 permanent bench marks established, 166 miles of primary traverse run, and 20 permanent marks set.

Vermont.—In cooperation with the Vermont State geologist, the survey of the Bolton quadrangle was completed and that of the Franklin Pond, Montgomery, and Northfield quadrangles was begun, the total area mapped being 361 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Franklin Pond and Montgomery quadrangles, 84 miles of primary levels were run and 19 permanent bench marks established.

Virginia.—In cooperation with the State geologist of Virginia, the survey of the Chatham quadrangle was completed, and that of the Callands quadrangle was begun, the total area mapped being 214 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Callands quadrangle and for new work 34 miles of primary levels were run, 9 permanent bench marks established, 140 miles of primary traverse run, and 42 permanent marks set.

West Virginia.—In cooperation with the State geologist of West Virginia, the resurvey of the Circleville, Hanging Rock, Richwood, and White Sulphur Springs quadrangles was completed and that of the Horton quadrangle was begun, the total area mapped being 658 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For control for new work, 361 miles of primary levels were run and 105 permanent bench marks were established. For the control of the Circleville and Durbin quadrangles 5 triangulation stations were occupied, 4 of which were marked. E. I. Ireland, topographic engineer, was in immediate charge of the field work.

West Virginia-Virginia.—In cooperation with the State geologist of West Virginia, the resurvey of the Wardensville quadrangle and the West Virginia portion of the Capon Bridge, Fort Seybert, Edinburg, McDowell, Middletown, and Orkney Springs quadrangles was completed, and that of the Winterburn quadrangle was begun, the total area mapped being 829 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The area mapped was all in West Virginia. For control for new work 137 miles of primary levels were run, 38 permanent bench marks established, and 11 triangulation stations occupied, 6 of which were marked.

OFFICE WORK.

The drafting of 23 sheets was completed and that of 10 sheets begun. Primary-level circuits were adjusted for 56 quadrangles. Geographic positions were computed for 44 quadrangles.

CENTRAL DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Iowa, Kentucky, Missouri, and Wisconsin. This work comprised the completion of the survey of 10 quadrangles and 9 special areas, in addition to which 11 quadrangles and 3 special areas were partly surveyed. Primary traverse was carried on by six parties in Illinois, Kentucky, Missouri, and Wisconsin.

Illinois.—In cooperation with the Illinois Department of Registration and Education, the survey of the Alto Pass, Buda, and Monmouth quadrangles was completed and that of the Liberty, Oregon, and Quincy quadrangles was begun, the total area mapped being 686 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For control for new work, 764 miles of primary levels were run, 195 permanent bench marks established, 741 miles of primary traverse run, and 178 permanent marks set.

In addition, the survey of a number of areas along certain proposed trunk-line highway routes was begun. These surveys of fractional areas have been designated as numbered projects. The survey of projects Nos. 1, 1A, 1B, 3, and 9 was completed, and that of Nos. 2 and 13 was begun, the total area mapped being 1,034 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. This work was done in such a manner as to be available for future incorporation in regular topographic maps.

The survey of the Virden special area was completed, the total area mapped being 298 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet.

Iowa.—In cooperation with the Iowa State Geological Survey, the survey of the Lehigh quadrangle was completed, the total area mapped being 116 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet.

Kentucky.—In cooperation with the Kentucky Geological Survey, the survey of the Bowling Green quadrangle was completed and that of the Frankfort and Mammoth Cave quadrangles was begun, the total area mapped being 285 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Frankfort and Mammoth Cave quadrangles 66 miles of primary levels were run and 20 permanent bench marks were established.

Kentucky-Illinois.—In cooperation with the State of Kentucky, the survey of the Cave in Rock quadrangle was completed, the total area mapped being 134 square miles (all in Kentucky), for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Leitchfield quadrangle 3 miles of primary traverse were run.

Missouri.—In cooperation with the Missouri State geologist, the survey of the Braymer and Chillicothe quadrangles was completed and that of the Cape Girardeau, Chula, Dawn, Hale, Polo, and Winston quadrangles was begun, the total area mapped being 1,182 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For control for new work 424 miles of primary levels were run, 110 permanent bench marks established, 251 miles of primary traverse run, and 56 permanent marks set.

Missouri-Illinois.—In cooperation with the State of Missouri, the survey of the Jonesboro quadrangle was completed, the total area mapped being 38 square miles (all in Missouri), for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 4 miles of primary levels were run.

Wisconsin.—In cooperation with the State geologist of Wisconsin, the survey of the South Wayne quadrangle was completed, the total area mapped being 180 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For control for new work 154 miles of primary levels were run, 51 permanent bench marks established, 511 miles of primary traverse run, and 131 permanent marks set.

In addition, the survey of the Gogebic range area was completed, the area mapped being 36 square miles, for publication on the scale of 1:24,000, with a contour interval of 10 feet.

The survey of highway projects Nos. A₁ and A₂ was also completed and that of highway project No. A₃ was begun, the total area mapped being 269 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these projects 87 miles of primary levels were run, 23 permanent bench marks established, 16 miles of primary traverse run, and 4 permanent marks set.

OFFICE WORK.

The drafting of 18 sheets was completed and that of 22 sheets was begun. Primary-level circuits were adjusted for 58 quadrangles. Geographic positions were computed for 80 quadrangles.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Arizona, Idaho, South Dakota, Texas, Utah, and Washington. This work comprised the completion of the survey of five quadrangles and one special area and the partial survey of 21 quadrangles. In addition, a profile survey was made of portions of two rivers. Triangulation and primary traverse were carried on by three parties in Idaho and Texas.

Arizona.—In cooperation with the National Park Service for work in the Grand Canyon the survey of the Supai quadrangle was continued, the total area mapped being 142 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

In addition, the survey of the Casa Grande Valley was continued, the total area mapped being 637 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. In connection with this project the survey of two quadrangles was completed and that of three quadrangles was begun. For the control of this area 41 miles of primary levels were run and 13 permanent bench marks were established. This work was done for the land-classification board, the topographic branch furnishing the services of experienced topographic engineers and the necessary instruments.

Arizona-Utah.—In cooperation with the Southern California Edison Co. the Geological Survey made special surveys and investigations in Arizona and Utah to ascertain the feasibility of storage and diversion of the waters of Colorado River. This was known as the Glen Canyon investigation. Surveys were carried from the mouth of Green River down Colorado River to Lees Ferry, Ariz., and in conjunction therewith surveys were carried from Bluff, Utah, down San Juan River to its mouth for the purpose of determining the capacity and extent of the reservoir, with a dam site located on Colorado River in the vicinity of Lees Ferry. In this work 485 square miles of topographic mapping (60 square miles in Arizona and 425 square miles in Utah) and 349 miles of river traverse were completed, for publication on the scale of 1:31,680, with contour intervals of 5 and 20 feet. In connection with this investigation a dam-site survey covering 7 square miles was completed in the vicinity of Lees Ferry on the scale of 1:4,800. For the control of this project about 425 miles of precise levels were run by the United States Coast and Geodetic Survey between Green River, Utah, and Flagstaff, Ariz. About 130 miles of these levels, between Halls Crossing and Lees Ferry, follow Colorado River.

Idaho.—In cooperation with the Forest Service triangulation was extended over the Idaho National Forest, 19 stations being occupied, 34 located, and 23 marked; 51 miles of primary levels were run and 14 permanent bench marks established. In connection with this work a reconnaissance photographic map covering 1,200 square miles in the Idaho National Forest was completed.

Idaho-Oregon.—In cooperation with the State Bureau of Mines and Geology of Idaho and the State Bureau of Mines and Geology of Oregon the survey of the He-Devil quadrangle was begun, the total area mapped being 128 square miles (82 square miles in Idaho and 46 square miles in Oregon), for publication on the scale of 1:62,500, with a contour interval of 50 feet.

South Dakota.—In cooperation with the State geologist of South Dakota, the survey of the Pierre quadrangle was begun, the total area mapped being 77 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 79 miles of primary levels were run and 17 permanent bench marks were established.

Texas.—In cooperation with the Texas Bureau of Economic Geology and Technology, the survey of the Corpus Christi quadrangle was begun, the total area mapped being 90 square miles, for publication on the scale of 1:62,500, with a contour interval of 5 feet. In connection with this work 25 miles of primary levels were run, 19 permanent bench marks established, 99 miles of primary traverse run, and 34 permanent marks set.

In cooperation with the State Board of Water Engineers, the survey of the Bronte-Ballinger irrigation project, consisting of the Bronte, Spur Creek, Hatchel, Quarry Creek, Miles, Mays School, Maverick, Marie, Baker Flat, Rowena, and Lowake quadrangles, was completed, the total area mapped being 355 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. In connection with this project the survey of a dam site covering

square mile on the scale of 1:1,200 was made, also the survey of a reservoir on the scale of 1:24,000 was completed, 3 square miles being mapped. For the control of this area 47 miles of primary levels were run and 12 permanent bench marks established.

In addition, 210 linear miles of road traverse in Henderson County, covering 32 square miles, were executed for the Bureau of Soils to serve as data for base maps on which to plot the soil classification. This work was done in such a manner as to be available for future incorporation in regular topographic maps.

Utah.—The survey of the Castle Dale, Hiawatha, and Monument Peak quadrangles, Utah, was begun, the total area mapped being 238 square miles, for publication on the scale of 1:31,680, with a contour interval of 50 feet. This work was done for the land-classification board, the topographic branch furnishing the services of an experienced topographic engineer and the necessary instruments.

Washington.—In cooperation with the Washington State Department of Conservation and Development, the survey of the Corfu and Sultan quadrangles was completed and that of the Othello No. 3 was begun, the total area mapped being 414 square miles, for publication on the scales of 1:62,500 and 1:125,000, with contour intervals of 25 and 100 feet. For the control of the Corfu quadrangle 32 miles of primary levels were run.

OFFICE WORK.

The drafting of 4 sheets was completed and that of 9 sheets begun. Primary-level circuits were adjusted for 13 quadrangles. Geographic positions were computed for 14 quadrangles.

PACIFIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in California, Hawaii, and Oregon. This work included the completion of the survey of 36 quadrangles and the partial survey of 3 quadrangles and 1 special area. In addition a profile survey of one river was completed. Triangulation and primary traverse were carried on by two parties in California and Hawaii.

California.—In cooperation with the California Department of Public Works, for work in San Joaquin Valley, the survey of the Auckland, Clovis, Fresno, Herndon, Malaga, Mendota, Monocline Ridge, No. 21, No. 25, No. 26, No. 27, Reedley special, Squaw Valley, and Wahtoke quadrangles was completed, the total area mapped being 563 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of the Riverdale quadrangle, 30 miles of primary traverse were run and 7 permanent marks set.

In cooperation with the United States Reclamation Service, the Klamath-Shasta Valley irrigation district, and the Department of Public Works of California, the survey of a portion of Shasta Valley was begun on a scale of 2,000 feet to the inch, with a contour interval of 5 feet, for preliminary study and planning the general outline of an irrigation system, it being understood that, if the project is found feasible, a resurvey on a larger scale will be necessary. In connection with this project, 298 square miles of topographic mapping was completed. For the control of this area, 109 miles of primary levels were run, 25 permanent bench marks established, and 38 triangulation stations occupied, 31 of which were marked.

In addition, 106 linear miles of river traverse along Klamath River were completed for the land-classification board, the topographic branch furnishing the services of an experienced topographic engineer and the necessary instruments.

Hawaii.—In cooperation with the governor of Hawaii, the survey of the Honakahau NW. $\frac{1}{4}$, Honakahau SW. $\frac{1}{4}$, Honuapo NW. $\frac{1}{4}$, Honuapo SW. $\frac{1}{4}$, Kahului NW. $\frac{1}{4}$, Kalae NW. $\frac{1}{4}$, Kaunakakai NE. $\frac{1}{4}$, Kaunakakai NW. $\frac{1}{4}$, Kaunakakai SE. $\frac{1}{4}$, Kaunakakai SW. $\frac{1}{4}$, Kilauea NE. $\frac{1}{4}$, Kilauea NW. $\frac{1}{4}$, Papohaku NE. $\frac{1}{4}$, Papohaku E. $\frac{1}{4}$, Pukoo NE. $\frac{1}{4}$, Pukoo SE. $\frac{1}{4}$, Pukoo SW. $\frac{1}{4}$, Pukoo NW. $\frac{1}{4}$, Puna NW. $\frac{1}{4}$, and Puna SW. $\frac{1}{4}$ quadrangles was completed and that of the Puna NE. $\frac{1}{4}$ and Puna SE. $\frac{1}{4}$ quadrangles was begun, the total area mapped being 655 square miles, for publication on the scale of 1:31,680, with contour intervals of 10 and 5 feet. For control for new work 201 miles of primary levels were run, 63

permanent bench marks established, and 16 triangulation stations occupied, 12 of which were marked. A. O. Burkland, topographic engineer, was in immediate charge of the field work.

Oregon.—In cooperation with the War Department, the survey of the Reedspoint quadrangle, Oreg., was completed, and that of the Earl quadrangle was continued, the total area mapped being 58 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

In cooperation with the State engineer, the survey of the Mount Angel quadrangle was completed, the total area mapped being 212 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet.

OFFICE WORK.

The drafting of 44 sheets was completed and that of 5 begun. Primary-level circuits were adjusted for 13 quadrangles. Geographic positions were computed for 15 quadrangles.

WATER-RESOURCES BRANCH.

ORGANIZATION.

The work of the water-resources branch was conducted under the supervision of N. C. Grover, chief hydraulic engineer, and is organized in five divisions:

Division of surface water, John C. Hoyt, hydraulic engineer, in charge.

Division of ground water, O. E. Melnzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

Division of enlarged and stock-raising homesteads, H. C. Cloudman, classifier, in charge.

PERSONNEL.

During the year the technical force was reduced 13 and was increased 14—a net increase of 1. At the end of the year the force consisted of 1 chief hydraulic engineer, 35 hydraulic engineers, 6 engineers, 26 assistant engineers, 23 junior engineers, 4 geologists, 1 assistant geologist, 1 chemist, 3 associate chemists, 10 classifiers, and 1 expert mechanic, a total of 111. Of this number 1 assistant engineer is on leave without pay, and 4 hydraulic engineers, 3 assistant engineers, 2 junior engineers, and 1 expert mechanic are employed occasionally. In addition, 12 members of the advisory board of the superpower survey hold appointments for occasional service in the study of problems relating to interconnection of power systems, especially those crossing State boundaries.

In the clerical force there were 4 separations and 2 accessions, and at the end of the year the force numbered 34. Of this number 5 are employed occasionally.

ALLOTMENTS.

The appropriation for gaging streams was \$180,000. In addition \$95,500 of the appropriation for classification of lands was expended for field work by the water-resources branch. Of the total appropriations, 79 per cent was allotted for work in public-land States. The cooperative funds made available by State allotments, amounting to \$217,010, have been increased in some States and decreased in others, making necessary corresponding adjustments of this work.

Allotments of appropriation for gaging streams, 1921-22.

Administration, general	\$17,658.02	Surface water—Continued.	
Ranch administration	10,300.00	Missouri	\$4,000.00
Computations	17,000.00	Kansas	3,500.00
Inspection	1,400.00	Colorado, Wyoming, and New Mexico	7,500.00
	<u>48,358.02</u>	Montana	5,000.00
Surface water:		North Dakota	300.00
Connecticut	500.00	Utah	5,000.00
Maine	1,000.00	Nevada	3,000.00
New Hampshire	1,500.00	Idaho	5,000.00
Vermont	1,000.00	Oregon	5,000.00
Massachusetts	2,500.00	Washington	5,000.00
New York	5,500.00	California	5,500.00
New Jersey	1,500.00	Arizona	3,500.00
Middle Atlantic States	3,000.00	Hawaii	4,500.00
South Atlantic States	5,000.00		<u>96,600.00</u>
Tennessee and Kentucky	3,000.00	Ground water	10,000.00
Ohio	3,000.00	Quality of water	14,000.00
Texas	5,000.00	Power resources	10,000.00
Wisconsin	3,500.00	General supplies	700.00
Minnesota	300.00	Contingent	2,341.98
Iowa	2,000.00		<u>180,000.00</u>
Illinois	1,500.00		

COOPERATION.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional service in field and office.

Alabama		\$110
Arizona:		
State water commissioner—		
Stream-gaging fund	\$3,000	
General fund	1,160	
		<u>4,160</u>
California:		
State engineer	12,185	
Division of water rights	9,730	
City and county of San Francisco	2,645	
Los Angeles County	3,325	
San Bernardino, Riverside, and Orange counties	2,995	
		<u>30,880</u>
Colorado		800
Georgia		270
Hawaii:		
Commissioner of public lands	28,520	
City and county of Honolulu	310	
		<u>28,830</u>
Idaho:		
Outside of Snake River basin	17,255	
SNAKE RIVER BASIN	1,933	
		<u>19,190</u>
Illinois		3,820
Iowa:		
State Highway Commission	2,300	
State Geological Survey	725	
		<u>3,025</u>
Kansas		3,885

Kentucky	\$650	
Maine	4,330	
Massachusetts	3,200	
Minnesota	810	
Missouri	9,810	
Montana	8,150	
Nevada	3,115	
New Hampshire	1,450	
New Jersey:		
State Department of Conservation and De-		
velopment	\$11,225	
City of Morristown	85	
Borough of Pompton Lakes	260	
		11,550
New York:		
State engineer	13,245	
City of Rochester	85	
		13,330
North Carolina	4,140	
North Dakota	585	
Ohio	6,000	
Oregon	11,530	
Tennessee	3,090	
Texas	14,635	
Utah	4,435	
Vermont	1,130	
Washington:		
Department of Conservation and Development	6,335	
City of Seattle	580	
City of Tacoma	100	
Intercounty River Improvement Commission	55	
		7,070
West Virginia	425	
Wisconsin	6,045	
Wyoming	6,580	
		217,010

The work done under cooperative agreements with the States has been restricted to studies of stream flow, except in Arizona, California, Connecticut, Idaho, and North Dakota.

Reclamation Service.—The measurement of streams that are to furnish water to reclamation projects under construction has been continued in cooperation with the United States Reclamation Service. The field work is done by Survey engineers who are employed in the locality, and the cost is repaid by the Reclamation Service through transfer of funds.

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued on the Crow, Fort Hall, Yakima, Colville, Klamath, Gila River, Shoshone, Western Shoshone, Walker River, and Uinta Indian reservations.

National Park Service.—Streams in the Yosemite, Yellowstone and Glacier national parks were measured during the year at stations maintained in cooperation with the National Park Service.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service. Stream gaging in the Arapaho and Uncompahgre national forests was done by the Forest Service, which was reimbursed by the Geological Survey.

City of San Francisco.—In connection with the proposed storage of the water of Tuolumne River in Hetch Hetchy Valley as a water supply

ply for the city of San Francisco, measurement of that stream was continued in cooperation with the city government.

Colorado River Commission.—Cooperation was extended to the Colorado River Commission by furnishing data in regard to stream flow and by starting a comprehensive system of gaging on the Colorado and its tributaries.

Federal Power Commission.—Projects of the Federal Power Commission in Oregon, California, Idaho, Colorado, and Arizona were examined. The operations of one California licensee of the commission are supervised by the Geological Survey, as well as the operations of one Arizona and one Oregon permittee of the commission. All stream gaging by permittees of the commission is done in cooperation with the Geological Survey. Such cooperative stream gaging is in progress in Virginia, North Carolina, South Carolina, Florida, Alabama, Louisiana, Arkansas, Washington, Idaho, Utah, Oregon, Arizona, California, Montana, Wisconsin, Colorado, and Iowa.

PUBLICATIONS.

The publications of the year prepared by the water-resources branch comprised 8 reports and 3 separate chapters. Titles and brief summaries of these publications are given on pages 9-10. At the end of the year 22 other reports were in press and 10 manuscripts were awaiting editorial work.

DIVISION OF SURFACE WATER.

ORGANIZATION.

The work of the division of surface water consists primarily of the measurement of the flow of rivers, but it includes also special investigations of conditions affecting stream flow and the utilization of the streams. In carrying on the work the United States is divided into 19 districts, including Hawaii. The district offices and engineers in charge are as follows:

- New England: C. H. Pierce, customhouse, Boston, Mass.
- New York: C. C. Covert, Journal Building, Albany, N. Y.
- New Jersey: O. W. Hartwell, State House, Trenton, N. J.
- Middle Atlantic and Ohio River: A. H. Horton, Washington, D. C.
- South Atlantic and eastern Gulf: W. E. Hall, 33-35 Broadway, Asheville, N. C.
- Tennessee: W. R. King, Municipal Building, Chattanooga, Tenn.
- Upper Mississippi River: S. B. Soule, Capitol Building, Madison, Wis.; sub-offices, Kimball Building, Chicago, Ill., and Ames, Iowa.
- Missouri-Kansas: E. L. Williams, Rolla, Mo.; suboffice, Federal Building, Topeka, Kans.
- Upper Missouri River: W. A. Lamb, Montana National Bank Building, Helena, Mont.
- Rocky Mountain: Robert Follansbee, Post Office Building, Denver, Colo.
- Great Basin: A. B. Purton, Federal Building, Salt Lake City, Utah.
- Idaho: C. G. Paulsen, Idaho Building, Boise, Idaho.
- Snake River basin: G. C. Baldwin, Federal Building, Idaho Falls, Idaho.
- Washington: G. L. Parker, Federal Building, Tacoma, Wash.
- Oregon: F. F. Henshaw, Post Office Building, Portland, Oreg.
- California: H. D. McGlashan, customhouse, San Francisco, Calif.; suboffice, Federal Building, Los Angeles, Calif.
- Arizona: R. C. Rice, care of University of Arizona, Tucson, Ariz.
- Texas: C. E. Ellsworth, Capitol Building, Austin, Tex.
- Hawaii: E. D. Burchard, Capitol Building, Honolulu, Hawaii.

CHARACTER AND METHODS OF WORK.

Field investigations necessary to the work are made from the district offices, where the results are sufficiently analyzed to insure accuracy and completeness. At selected places, known as gaging stations, the volume of water carried by the streams is measured and records of stage and other data are collected from which the daily flow of the streams is computed. Data collected from the district offices are transmitted to Washington, where they are reviewed in the computing section and prepared for publication. By this review the records obtained in different parts of the country are brought to a uniform standard, and standardization is further effected through annual conferences of the engineers.

At the end of the year 1,540 gaging stations were being maintained, including 77 in Hawaii; 258 stations were discontinued and 444 new stations established during the year. Records for about 165 additional stations were received, ready for publication, from a number of Government bureaus and private persons, and a number of Government and State organizations and individuals also co-operated in the maintenance of the regular gaging stations.

Gaging stations and cooperating parties for the year ended June 30, 1922.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Office.	Army engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gaging during year.	Miscellaneous gaging during year.
Alabama.....					1	1		2	2	5	1	10	9	3	29	5
Arizona.....		1						22		1	5	22	1	13	567	52
Arkansas.....										2		2	2		2	
California.....			23	1		1	6	193	44	65	140	193	43	3	2,789	643
Colorado.....	5	1	8			1		19	1	3	3	35	1	5	133	
Connecticut.....	1									2		2	3	3	4	
Florida.....										2		2	3	1	3	
Georgia.....					2	2		4		9	3	14		1	8	
Idaho.....		4	8	14		2		93	1	187	73	236	124	124	1,578	268
Illinois.....					1	3	7	27	1	1	13	27	3	5	96	6
Indiana.....										2		2	1		1	
Iowa.....						5		20		7	4	28	1		103	2
Kansas.....						2		30	1	9	12	30	14	1	120	4
Kentucky.....						1		4				5			7	3
Louisiana.....										1		1	1			
Maine.....								16		4	4	16		1	70	
Maryland.....	3											3			8	
Massachusetts.....								17				17			92	1
Michigan.....										1		1	1	1	1	
Minnesota.....					2	2		6				10			38	
Missouri.....						2		43		7	7	45	40		269	14
Montana.....	8	32	2	11				70		1		124	23	24	438	63
Nevada.....				3				29		12	15	29	7	2	165	27
New Hampshire.....								10		6	6	10	1	4	78	
New Jersey.....								26	3	6	9	26	26	1	229	43
New Mexico.....	1											1			1	
New York.....					1	2		54	1	16	20	54	6	7	233	14
North Carolina.....					14	1		4		6		25	24	20	158	6
North Dakota.....								8				8	3		17	
Ohio.....					2	7		21	10	4	2	42	40		217	24
Oregon.....		2	1	9		3		92	29	24	68	92	18		485	20
South Carolina.....										2		2	2		7	
Tennessee.....					26	11		35		9	46	35		1	140	
Texas.....						3		50	6	8	17	50	13	3	365	67
Utah.....		1		4				54	1	22	28	54	5	9	219	38
Vermont.....								11		6	6	11	2	3	41	11
Virginia.....	3				7	1				4	1	14	1		43	1
Washington.....	2		3	10			2	64	22	28	63	68	2	11	439	14
West Virginia.....					6			11		5	6	16	2		55	2
Wisconsin.....					3			43		9	12	43	1	2	161	
Wyoming.....		7	1	6		1	2	42		10	12	57	2	2	217	5
Hawaii.....								77	3	29	32	77	21	8	343	53
	22	49	46	58	65	51	17	1,197	125	515	605	1,540	444	258	9,969	1,141

PUBLICATIONS.

For convenience and uniformity in publications the United States has been divided into 12 primary drainage basins, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions; the records for the twelfth division are published in three papers. In addition to the progress reports, special reports on hydraulic subjects have been completed for publication during the year.

DIVISION OF GROUND WATER.

GENERAL FEATURES.

The division of ground water investigates the waters that lie below the surface—their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and at watering places for live stock and desert travelers. Each year surveys are made of selected areas where the problems of water supply are most urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to quality of water are made in cooperation with the division of quality of water; the surveys in the Atlantic Coastal Plain and in the West Indies are made by the geologic branch. Reports on parts of Mississippi, South Carolina, and Texas are not yet completed or are awaiting publication.

Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the United States Government, especially by the War and Navy departments. The ground-water division is called upon to furnish information and advice on a large number of these projects.

Important features of the year's work were (1) cooperation with the State of Idaho in a systematic survey of the artesian and other ground-water resources of that State, especially to develop irrigation supplies; (2) cooperation with the States of North Dakota and South Dakota and with the North Dakota Well Drillers' Association in their efforts to adopt effective legal and mechanical methods to conserve the artesian-water supply by preventing excessive waste from approximately 15,000 flowing wells in these States; and (3) cooperation with the United States Public Health Service in its experiments at Fort Caswell, N. C., to determine the extent to which *Bacillus coli* and the germs of typhoid fever are transported by ground water. Norah E. Dowell was assigned to the Fort Caswell laboratory during the month of May.

A comprehensive work on ground water in the United States, with a discussion of principles, is being prepared by O. E. Meinzer. Part I, which relates to the occurrence of ground water, was completed in the fiscal year 1921, and Part II, which relates to the origin, discharge, and quantity of ground water, is in preparation. Short papers were prepared by Mr. Meinzer on Pleistocene lakes, by Kirk Bryan on the origin of the water of the Arkansas Hot Springs, and by D. G. Thompson on the hydrology of playas.

Cooperation with the committee on physiography was continued through Mr. Meinzer, who serves on that committee. Several manu-

scripts for geologic folios were examined with respect to their treatment of the subject of ground water.

WORK BY STATES.

Arizona.—Progress was made on a report on the geology and water resources of San Pedro Valley, Ariz., by Kirk Bryan, of the Geological Survey, and G. E. P. Smith, of the Arizona Agricultural Experiment Station. A brief report on the water supply of the Santa Rita range reserve was made by Mr. Bryan to the United States Forest Service.

Arkansas.—A brief report as to methods for increasing the supply of hot water in the Hot Springs National Park was made by Mr. Bryan for the National Park Service.

California.—Much progress was made by Mr. Thompson on a comprehensive paper on the geography, geology, and hydrology of the Mohave Desert region, Calif. A special report on the Mohave Valley by Mr. Thompson was filed in the office of the United States Geological Survey in Los Angeles, where it is accessible to the public. A report regarding a water supply on San Miguel Island was made by Mr. Thompson to the United States Public Health Service. A report on ground water in the Napa quadrangle was prepared by Miss Dowell, on the basis of field work previously done by W. O. Clark, to be published in a geologic folio. An investigation as to means for increasing the water supply for the Mariposa Grove of Yosemite National Park was made in June by Mr. Bryan for the National Park Service. Water levels were measured in selected wells in southern California, as in previous years, under the direction of F. C. Ebert.

The large amount of ground-water work in California is made possible through financial cooperation of the State Department of Engineering.

Connecticut.—Reports on the New Haven area, Conn., and on the relation of sea water to ground water, with special reference to the Connecticut coast, were completed by J. S. Brown. Additional field work was done in the Pomperaug Valley by Miss Dowell, and a report on the quantitative study of the water in that valley has been nearly completed. All work in Connecticut is done in cooperation with the State Geological and Natural History Survey.

District of Columbia.—A brief report regarding a ground-water supply for the Government Printing Office was prepared by Mr. Thompson, and an examination of the sanitary conditions at the wells that supply St. Elizabeths Hospital was made by Mr. Meinzer in cooperation with the Public Health Service.

Hawaii.—An investigation of ground water in the Kau district, Hawaii, was nearly completed by Mr. Clark prior to his resignation, December 31, 1921, but the report has not yet been submitted.

Idaho.—An intensive investigation of the water resources of the Mud Lake basin, Idaho, begun in April, 1921, was carried on during the year by L. L. Bryan, who did the engineering work, and H. T. Stearns, who did the geologic work. A preliminary report, including an inventory of the water supply for the year ending March 31, 1922, was completed, and on June 30 it was being mimeographed. Field work for the final report is still in progress. Financial cooperation was received from the Idaho Department of Reclamation, the United States General Land Office, and the Idaho Bureau of Mines and Geology. The work was under the technical supervision of the ground-water division and the Boise district of the division of surface water.

A systematic investigation of the artesian and other ground-water resources of Idaho, in cooperation with the State Bureau of Mines and Geology, was begun in May, 1921, and was continued through this fiscal year. Mr. Meinzer made a general reconnaissance of large parts of the State east of Twin Falls. He prepared a brief report on Pahsimeroi Valley, which is to be published by the State, and a paper entitled "Ground water for irrigation in Idaho," which he presented to the Idaho Irrigation Congress. A survey of the Goose Creek artesian basin was made by A. M. Piper. A brief preliminary report on artesian conditions in the vicinity of Grand View was made by Mr. Stearns.

Maryland.—A brief report on prospects for developing a ground-water supply in the vicinity of Silver Hill, Md., was made by Mr. Thompson to the Secretary of the Interior.

Montana.—Surveys of ground water in Yellowstone, Treasure, and Big Horn counties, Mont., were made by G. M. Hall, and a survey of ground water in the Townsend area, with special reference to artesian prospects, was made

by J. T. Pardee. A mimeographed preliminary report on the Townsend area was issued as a press notice.

Nevada.—A brief investigation of the prospects of developing irrigation supplies from wells in the vicinity of Searchlight, Nev., was made by D. F. Hewett, of the geologic branch.

North Dakota.—Progress was made by H. E. Simpson, State water geologist, on a comprehensive report on ground water in North Dakota. This work is being done in cooperation with the State Geological Survey. In January Mr. Meinzer conferred with Professor Simpson and others at an interstate conference on the conservation of the artesian-water supply.

Virginia.—A brief report on a water supply for Manassas, Va., was made by Mr. Thompson.

DIVISION OF QUALITY OF WATER.

The division of quality of water makes analyses of surface and ground waters and interprets such analyses to determine the suitability of the waters, as far as mineral content is concerned, for domestic and industrial uses and for irrigation. During the year 671 samples of water were analyzed. These included 118 samples from Yellowstone, Big Horn, and Treasure counties, Mont., that were analyzed by C. S. Howard, who has written a discussion of the quality of ground water in Yellowstone County. Mr. Howard also wrote a discussion of quality of water for the report by Alexander Deussen on ground water in the Coastal Plain of Texas southwest of Brazos River. The 196 analyses of ground waters in North Dakota were nearly all made by H. B. Riffenburg, who has begun to write the discussion of quality of water for the report by Professor Simpson on the ground waters of North Dakota. Analyses of 90 samples from public water supplies were made by Margaret D. Foster for use in a report on the industrial utility of public water supplies. Miss Foster also studied the details of several of the analytical methods in use in the laboratory. Some of the results of this work are included in a mimeographed report on field examination of water by W. D. Collins. Analyses were made for Miss Dowell's Fort Caswell study (58), Mr. Thompson's study of soils in the Mohave Desert (40), Mr. Brown's Haitian reconnaissance (20), and a study of the availability of Pecos River water for irrigation in Texas (20). Sections on quality of water in four ground-water reports and two geologic folios were reviewed. The report on production of mineral waters in 1920 was prepared by Mr. Collins.

DIVISION OF POWER RESOURCES.

The work of the division of power resources during the year comprised the preparation of monthly reports of the production of electricity and consumption of fuel by public-utility power plants, of State maps showing the location of the power stations and transmission lines used in public service, and of a report on developed and potential water power of the United States.

The monthly reports of power production are based on reports submitted by public-utility companies showing their monthly output of electricity and the fuel consumed in generating it, if fuel is used. About 2,350 companies operating 3,500 power plants, each having a monthly output of 10,000 kilowatt-hours or more, are requested to submit reports of their production of electricity and consumption of fuel. The reports received represent about 90 per cent

of the total generating capacity of these plants. Each report is now published within 30 days after the end of the last month included in it. The following tables show the power and fuel statistics for the calendar years 1919, 1920, and 1921:

Electricity produced at public-utility power plants in the United States, 1919-1921.

Year.	Total.		Water power.			Fuel power.		
	Kilowatt-hours.	Change from previous year (per cent).	Kilowatt-hours.	Per cent of total.	Change from previous year (per cent).	Kilowatt-hours.	Per cent of total.	Change from previous year (per cent).
1919.....	38,921,000,000		14,606,000,000	37.5		24,315,000,000	62.5	
1920.....	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921.....	40,976,000,000	-5.9	14,971,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1

Fuel consumed in the production of power at public-utility plants in the United States, 1919-1921.

Year.	Coal.		Fuel oil.		Gas.	
	Short tons.	Change from previous year (per cent).	Barrels.	Change from previous year (per cent).	M cubic feet.	Change from previous year (per cent).
1919.....	35,100,000		11,050,000		21,406,000	
1920.....	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921.....	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.0

Maps showing the location of the power stations and transmission lines used in public service and the names of the public-utility companies and their plants were published for Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Maryland, Delaware, District of Columbia, Virginia, and Indiana.

The report on the developed and potential water power of the United States was published in February as a press notice. It contains tables that show for each State the total installed capacity of water wheels in plants of 100 horsepower or more and the maximum and minimum potential water power. The table of developed water power shows that near the end of 1921 there were in the United States 3,120 water-power plants of 100 horsepower or more, with a total installed capacity of 7,926,958 horsepower. Of this total 78 per cent is in public-utility plants and 22 per cent in manufacturing plants. The five leading States and the amount of developed water power in horsepower in each are as follows: New York, 1,291,857; California, 1,149,099; Washington, 454,356; Maine, 449,614; and Montana, 344,420.

DIVISION OF ENLARGED AND STOCK-RAISING HOMESTEADS.

The work of the enlarged and stock-raising homestead division is divided into two distinct classes—the examination of public lands for

designation under the enlarged and stock-raising homestead laws and the examination of streams and neighboring lands as a basis for the classification of public lands with respect to their value for water power or irrigation.

In the season of 1921 the examination of lands applied for under enlarged and stock-raising homestead laws was started as early as possible without incurring loss of time because of bad weather and was therefore in full progress at the beginning of July. It was continued generally until November. Twenty classifiers of various grades, including five assigned from the land-classification board, were engaged in field work during the whole or part of the season.

Field examination under the stock-raising homestead law was confined generally to lands for which applications had already been made and was begun in land districts where no work was done last year or the work was not finished. At the beginning of the year about 3,000 applications requiring field examination of the lands involved were on hand. In addition to individual examination of the lands included in most of these applications, reconnaissance examinations were made, for the designation of block areas, in all the States in which work was done except California. The lands in the following States included in applications pending at the beginning of the year were examined:

Arizona: All districts.

California: All districts.

Colorado: Del Norte, Denver, Durango, Glenwood Springs, Montrose, and Pueblo.

Idaho: Blackfoot, Boise, Halley, Lewiston.

Montana: Bozeman, Glasgow, Great Falls, Havre, and Lewistown districts and most of the Billings, Helena, Kallispell, Miles City, and Missoula districts.

Nebraska: All of western part.

Nevada: All districts.

New Mexico: All districts.

North Dakota: All districts.

Oregon: La Grande district and most of the Burns, The Dalles, and Vale districts.

South Dakota: All districts.

Utah: All districts.

Washington: All districts.

Wyoming: Practically all districts.

Field examination of entries under the enlarged-homestead act was confined during the summer of 1921 mostly to Colorado, Wyoming, New Mexico, Arizona, California, and Oregon. Lands included in a few entries in other States were examined in connection with the examination of stock-raising homesteads.

During the field season of 1922 the force engaged in the examination of lands subject to entry under the stock-raising homestead law has been assigned also to the examination of lands applied for under the enlarged-homestead laws. Field work was begun early in June and at the end of the month was in progress in California, Colorado, Idaho, Montana, North Dakota, Oregon, Utah, and Wyoming.

The reconnaissance investigation of the surface and ground-water resources of Nevada that was begun in the spring of 1921 for the purpose of classifying lands under the ground-water reclamation act was continued during the summer of that year, and in June, 1922, a brief additional reconnaissance was made to supplement the data previously obtained.

For the purpose of classifying lands with relation to their value in connection with the development of water power, surveys were made of water-power possibilities on Salmon River from Salmon, Idaho, to the mouth of the river and of Big Horn River through Big Horn Canyon, Wyo.; and the surveys begun last year along Siuslaw River and tributaries, Oreg., and on Snake River from Milner to Weiser, Idaho, were completed.

A reconnaissance examination of power-site withdrawals along Arkansas River and headwater tributaries west of Pueblo, Colo., including profile surveys of streams, was in progress in the summer of 1921 and is being continued this year for the purpose of obtaining sufficient data to prepare a general report on the utilization of that portion of the Arkansas River basin.

Examinations were made in the Bear River basin, Utah and Idaho, and in the Green, Sevier, and Weber River basins, Utah, in order to determine where water-power development exists in trespass and whether all lands that should be reserved for power purposes are included in power-site reserves.

In California examinations were made of power and irrigation possibilities in the Feather and Kaweah River basins, and a reconnaissance of the power-site value of lands in the Eel and Mad River basins is now in progress.

In order to designate dam sites for detailed survey and to obtain information necessary for preparing a report on the water-power resources of Colorado River between the mouth of Green River and Lees Ferry, Ariz., an engineer was detailed to a topographic party making a survey of that stretch of the river. Another engineer was assigned to locate dam sites on Klamath and Trinity rivers, Calif., for detailed survey by a topographic party.

A report on Klamath River in Oregon and California and its utilization, based on an examination made last year, has been completed in manuscript form and will be published as a water-supply paper.

The manuscript of a report on the water resources of Uinta Basin, Utah, and their utilization was prepared from information already at hand combined with the results of a little field work. This report will be published as a water-supply paper.

Some revision has been given to reports on the water powers of the Great Salt Lake basin, Utah, and on the water powers of New Mexico.

LAND-CLASSIFICATION BOARD.

ORGANIZATION AND PERSONNEL.

The work of the land-classification board consists of classification based on mineral character and classification based on water supply, and the corresponding units of organization are the division of mineral classification and the division of hydrographic classification. The latter division includes three more or less distinct sections, each dealing with a type of classification work in which water supply is an essential element. At the end of the fiscal year the organization and the technical personnel were as follows:

Chief, W. C. Mendenhall, geologist.

Chief engineer and assistant chief, Herman Stabler.

Secretary, Elsie Patterson.

Division of mineral classification: J. D. Northrop, geologist; C. D. Avery, mining engineer; G. W. Holland and N. W. Bass, classifiers; W. W. Boyer, associate geologist.

Division of hydrographic classification: Power section: B. E. Jones and W. G. Hoyt, hydraulic engineers; N. J. Tubbs, engineer; E. E. Jones, classifier; Warren Oakey, assistant engineer. Irrigation section: J. F. Deeds, hydraulic engineer; C. E. Nordeen, topographic engineer; W. N. White, classifier. Grazing section: J. G. Mathers, engineer; A. E. Aldous, W. L. Hopper, and R. O. Helland, classifiers.

In addition two engineers, R. W. Davenport and D. J. Guy, have been detailed from the board for duty with the Federal Power Commission.

During the year there were 2 additions to the force and 10 separations. At its end the total number of persons on the regular staff, including the clerical force and employees detailed to the Federal Power Commission, was 53. In addition to this regular force 14 classifiers on the rolls of the water-resources branch joined the staff of the land-classification board during the office season in connection with the stock-raising homestead classifications.

SCOPE AND CHARACTER OF THE WORK.

The land-classification board was organized to perform the duties relating to "the classification of public lands" with which the Geological Survey is charged by the law of March 3, 1879 (20 Stat. 394). Since its organization the board has prepared and recommended withdrawals of lands known or believed to be valuable for coal, planned their examination, classified and appraised them, and initiated their restoration to the public domain for disposal in accordance with their classification. It has recommended the creation of oil, phosphate, and potash reserves pending the enactment by Congress of appropriate laws for the disposition of the minerals involved. It has classified large areas of oil-shale lands and has selected the lands to be set aside as oil and oil-shale reserves for the Navy and drafted orders for their withdrawal. It has formally classified as to all minerals all or parts of several Indian reservations and as to metalliferous minerals extensive areas of land within the Northern Pacific Railroad grant, the board planning the examination, the Indian Office furnishing the funds, and the geologic branch executing the field work. It has initiated withdrawals of lands valuable for the development of water power in order to prevent possible serious interference with their use for that purpose and bears an important part in facilitating the utilization of the withdrawn lands for water-power development. It prepares and recommends designations required prior to allowance of applications for entry of lands under the enlarged and stock-raising homestead acts.

Under the mineral leasing act of February 25, 1920 (41 Stat. 437), the classified mineral lands and the mineral reserves previously created on recommendation of the board are subject to lease, and the board is required to define the "known geologic structure" of producing oil or gas fields, to determine what is leasing and what is prospecting ground, to recommend the creation of leasing units, to suggest appropriate requirements as to royalty, minimum annual production, and minimum investment, and generally to make the

classifications and to give advice on the geologic and economic problems that must be solved to render the leasing act effective.

The tasks that arise in connection with the work above outlined are performed on the basis of records accumulated during 43 years of activity by the Survey in mapping the topography and investigating the mineral and water resources of the public domain. If existing records are deficient and can not be supplemented satisfactorily from other scientific sources, the board prepares plans for field investigation and makes an allotment from its funds to such other branch of the Survey as is best equipped to obtain the needed information. In a sense the land-classification board is a repository of essential data relating to the natural resources of the public domain and a clearing house for information of many types required in the administration of the laws enacted by Congress and the policies adopted by the Executive for the conservation and utilization of those resources.

The greater part of the information disseminated by the board is utilized through the General Land Office and the office of the Secretary of the Interior, where such facts as to the character of lands are needed as a basis for the administration of certain laws and the development of certain policies. Much of the land-classification work is done under a plan of procedure arranged with the General Land Office, which involves the submission of technical reports on numerous types of cases before that office and the department for disposal. Other bureaus and offices of the Interior Department, as well as other departments of the Government, are also supplied with information pertaining to the character of the public domain.

FUNDS.

The sundry civil act of March 4, 1921, appropriated \$300,000 for the classification of lands by the Geological Survey in the fiscal year ended June 30, 1922. Expenditures from this appropriation by the several branches of the Survey for general administration, for the office work of the land-classification board, and for field work currently needed as a prerequisite thereto, were substantially as follows:

Administrative branch	\$25, 800
Alaska branch	2, 000
Geologic branch	38, 800
Land-classification board	110, 400
Topographic branch	25, 500
Water-resources branch	95, 500

298, 000

The remainder of the appropriation (\$2,000) was withheld from use in much needed work on request of the Bureau of the Budget as a part of its economy program.

CORRESPONDENCE.

During the year 20,719 letters and petitions were received by the land-classification board, about 28 per cent less than in the preceding year. In addition, 5,475 copies of miscellaneous correspondence were sent to the board for its information and filing; this correspondence

made up largely of letters from the General Land Office to its officers and of reports on the character of lands by its inspection examiners, copies of decisions rendered by the Department of the Interior, and copies of withdrawals and restorations recommended by the Reclamation Service. Within the same period 17,704 were prepared by the board, or 2½ per cent less than in the preceding year. These figures show an average of 68 incoming letters and 58 outgoing letters for each working day of the year.

SUMMARY OF CASES.

The information supplied by the board is furnished either in response to specific requests for data or in the form of broad areal classifications made under the laws relating to public domain and its natural resources. The following table is a summary of the cases before the board for action during the year and indicates that reports were rendered on more than 25,000 requests. The number of cases disposed of, however, is of little significance in the light of the fact that some require only a few days' consideration, whereas others require exhaustive study and work extending over several days or weeks, and some necessitate extensive investigations.

General summary of cases.

Class of cases.	Record for fiscal year 1921-22.						Record since receipt of first case.	
	Pending July 1, 1921.	Received during fiscal year.	Total.	Acted on during fiscal year.	Pending June 30, 1922.	Gain or loss during fiscal year.	Received.	Acted on.
Land Office requests.....	2,894	1,518	4,392	3,500	893	+1,393	.....	.....
Cases for classification as to								
.....	28	21	49	23	26	+2	794	606
.....	186	1,021	1,177	1,045	133	+24	1,578	1,448
.....	1	1	1	1	1	.....	28	27
Cases for mineral permits.....	994	7,318	8,253	7,539	713	+221	15,361	15,178
Cases for mineral leases.....	30	114	144	97	47	-17	243	196
Cases for patent, potassium	.....	2	2	2	.....	.....	14	14
over Commission cases:								
.....	26	8	34	32	2	+24	35	33
.....	3	6	8	7	1	+2	8	7
.....	25	12	37	35	2	+23	37	35
.....	12	9	21	14	7	+5	617	610
.....	18	160	178	167	9	+7	5,086	5,067
.....	16	18	34	26	9	+7	856	847
Cases under enlarged-homestead	996	1,020	1,996	1,263	733	+243	53,537	52,814
Cases under stock-raising and ad	3,443	6,764	15,197	11,298	3,901	+4,542	100,079	96,178
Cases under ground-water	111	144	255	213	42	+60	588	546
.....	18	10	28	23	5	+13	9,475	9,470
.....	11	11	11	9	2	-3	274	272
.....	13,649	18,145	31,794	25,260	6,504	+7,145	.....	.....

DIVISION OF MINERAL CLASSIFICATION.

The activities of the division of mineral classification are directed along three primary lines of effort involving, first, the withdrawal, cession, and restoration of public lands known or believed to have mineral value; second, the solution of geologic problems

arising in the administration of the act providing for leasing of mineral lands; and, third, the preparation of reports concerning the mineral character of specific lands for the information and guidance of other Government bureaus charged with the administration of the public land and Indian land laws.

Despite the preoccupation of the division with urgent problems pertaining to the second phase of its activities, substantial progress was made during the year along the broader lines of mineral-land classification.

The approval of the potash-land leasing act in October, 1917, and of the general mineral-lands leasing act in February, 1920, remove in effect the necessity for further withdrawals of lands known or believed to contain deposits of coal, oil, gas, phosphate, oil shale, sodium, or potash, but it did not obviate the necessity for the classification and restoration to the public domain of some 50,000,000 acres then embraced in outstanding mineral-land withdrawals. To this unfinished task the mineral division is devoting as much energy as the limitations imposed by small personnel, inadequate geological information, and pressure of more urgent tasks will permit. The results accomplished in the fiscal year include a net reduction of 459,341 acres in the total area previously classified as coal land, a net increase of 268,359 acres in the area previously classified as phosphate land and decreases of 3,914,988 acres, or 10 per cent, in the area of outstanding coal withdrawals, of 110,803 acres, or about 2 per cent, in the area of outstanding petroleum reserves, and of 298,844 acres, or 11 per cent, in the area of outstanding phosphate reserves. No change was effected during the year in the areas previously classified as oil land, withdrawn or classified as oil-shale land, included in potash reserves, or withdrawn on account of concealed deposits of metalliferous minerals.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table

Summary of outstanding mineral withdrawals and classifications, June 30, 1922, in acres.

State.	Coal.		Oil.	
	Withdrawn.	Classified as coal land.	Withdrawn.	Classified as oil land.
Alaska.....		56,993		
Arizona.....	141,945		230,400	
Arkansas.....		61,160		
California.....	17,643	8,720	1,178,392	
Colorado.....	4,277,957	3,170,645	222,977	
Florida.....				
Idaho.....	4,761	4,603		
Louisiana.....			468,980	
Montana.....	10,612,683	6,585,071	1,350,937	42,067
Nevada.....	83,833			
New Mexico.....	5,369,349	582,684		
North Dakota.....	5,954,364	11,178,286	84,894	
Oregon.....	4,361	18,887		
South Dakota.....		250,093		
Utah.....	5,179,100	1,101,587	1,962,787	
Washington.....	691,852	141,444		
Wyoming.....	2,437,283	6,736,313	1,069,176	
	34,775,131	29,806,496	6,586,553	42,067

Summary of outstanding mineral withdrawals and classifications, June 30, 1922, in acres—Continued.

State.	Oil shale.		Phosphate.		Potash (with- drawn).
	With- drawn.	Classified as oil-shale land.	With- drawn.	Classified as phos- phate land.	
California.....					90,518
Colorado.....	41,560	952,239			
Florida.....			119,563		
Idaho.....			720,534	267,722	
Montana.....			287,883		
Nevada.....	123				39,422
Utah.....	86,584	2,705,035	302,465		
Wyoming.....		460,103	996,049	25,293	
	128,267	4,117,377	2,425,494	293,015	129,940

The contributions of the mineral division to the administration of the mineral-lands leasing acts are fundamental and important. They involve, with respect to coal, the determination whether a prospecting permit or a lease should be issued and, if a lease is required, the establishment of a leasing unit consistent in area and content of coal with the mining operation to be undertaken and the recommendation of appropriate stipulations in the matters of royalty, minimum investment, and minimum annual production. With respect to oil and gas they require the definition of "the known geologic structure" of producing oil or gas fields as the primary distinction between leasing and prospecting areas, the determination of the structural relations of lands embraced in prospecting-permit applications, and the classification of all tracts included in such applications which are at the same time involved in imperfect entries under the nonmineral-land laws. Similar types of essential service involving decisions based on geologic evidence are rendered in the administration of the potash-land leasing act and the sections of the general mineral-lands leasing act pertaining to phosphate, oil shale, and sodium.

The following table summarizes the year's activities of the division to the extent that they involve the consideration of specific applications for permit or lease rights under the leasing acts:

Applications under the mineral leasing acts, fiscal year 1921-22.

Mineral.	Permits.			Leases.			Patents.		
	Re- ceived.	Acted on.	Pend- ing.	Re- ceived.	Acted on.	Pend- ing.	Re- ceived.	Acted on.	Pend- ing.
Oil and gas.....	6,647	7,051	462						
Coal.....	515	345	234	106	91	43			
Phosphate.....				4	3	1			
Sodium.....	8	10	2		1				
Potassium.....	148	133	15	3	2	1	2	2	
Oil shale.....				1		2			

The broader phases of the division's activities under the leasing acts were restricted during the year almost entirely to its designa-

tions of the boundaries of the "known geologic structure" of producing oil and gas fields—that is, the designation of the lands that are subject to lease only, as distinguished from those on which prospecting permits may be granted. The results, which involve an exhaustive study of each area considered, include definitions of the Gas City and Baker gas fields, in Montana, and the Hidden Dome and Little Grass Creek gas fields and Bolton Creek oil field, in Wyoming, together with a revised definition of the Mahoney Dome gas field, in Wyoming. At the end of the year 38 fields, having a total area of 343,082 acres, had been defined.

In the matter of reports rendered in response to requests of the General Land Office and the Office of Indian Affairs for information concerning the mineral possibilities of specific lands, gratifying progress resulted from a special effort made during the year to dispose of the excess of pending cases accumulated during the period in which the efforts of the division were necessarily centered on its functions under the leasing acts. The general summary of cases (p. 65) shows a net gain of 1,982 such cases involving reports to the General Land Office and of 13 cases involving reports to the Office of Indian Affairs. The anticipated effect of this effort is the attainment of current status in this phase of divisional activity early in the ensuing fiscal year.

In all the types of activity pursued by the division the requisite of definite information on which to base decisions and recommendations of appropriate action has necessitated the planning and financing of considerable field work, both reconnaissance and detailed, undertaken by the geologic and topographic branches.

DIVISION OF HYDROGRAPHIC CLASSIFICATION.

POWER SECTION.

The work of the power section consists primarily in obtaining and making available for administration under the public-land laws information as to the water-power resources of the public lands. Reports are made on specific problems as they arise, such problems ordinarily involving conflict between projects for power development and applications under the land laws. The endeavor is made to reach solutions by which the possibilities for developing power may be preserved with a minimum of interference with agricultural, transportation, or other interests. In connection with these specific problems and also in a broad way constant review is being made of power reserves in order that all land having material value for the development of power, and only such land, shall be held reserved for that purpose. The extent of this task is indicated by the fact that over 4,000,000 acres of land is included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that its information may be substantially complete, the section designates areas not thoroughly surveyed for examination

by the field branches of the Survey. Important items of field work to obtain data for power classification in progress at the request of the land-classification board and financed by allotments from its funds during the year included plan and profile surveys of Colorado River between Green and Paria rivers, Utah and Arizona, and of Klamath and Trinity rivers, California; and detailed studies and reports on the possibilities of developing power in the Klamath River basin, Oregon and California; Kaweah River, California; Siuslaw River, Oregon; Snake River, Idaho, Oregon, and Washington; Salmon River, Idaho; Bear River, Idaho and Utah; the Uinta Basin, Utah; Arkansas River, Colorado; and Big Horn River, Montana and Wyoming. All such information as it becomes available is carefully indexed and incorporated in an inventory of water resources maintained by the land-classification board, which, when complete, will enable the section to give competent advice on short notice as to the manner in which each tract of public land having value for power can best be used in connection with the development of water power and as to the relation of such use to other possible uses of the tract.

The work of the section, in so far as it is readily subject to statistical record, is briefly summarized in the table of power-site reserves, the table of outstanding water resources and agricultural withdrawals and classifications, and the general summary of cases. Certain features of the operations under power permits and grants issued prior to the passage of the Federal water-power act, as disclosed by reports made on request of the section, are summarized in the following paragraph.

Pursuant to the instructions of the Secretary, dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1258), to whom rights have been granted by the Secretary of the Interior since January 1, 1913, were called upon for detailed reports of the operations or developments of their power systems during the calendar year 1921. An examination of these reports shows that the total installation of the 59 reporting companies is 1,260,000 kilowatts, of which 1,010,000 kilowatts is installed at hydroelectric plants. The total energy generated amounted to 3,725,000,000 kilowatt-hours, of which 3,400,000,000 kilowatt-hours was generated by water power. A total of 52,430,000 kilowatt-hours was purchased from companies which have no portion of their plants under permit or grant from the Interior Department. Of the amount purchased 42,970,000 kilowatt-hours was generated by water power. The operating expenses for the companies generating 100,000,000 kilowatt-hours or more a year (90 per cent of which was generated by water power), including taxes and depreciation, averaged 8.7 mills per kilowatt-hour sold. The gross income from electrical operations of the same companies was 16 mills per kilowatt-hour of energy sold.

Power output of permittees and grantees, 1916-1921.

Year.	Number reporting.	Kilowatt-hours.	Increase or decrease.	
			Kilowatt-hours.	Per cent.
1916.....	26	1,200,000,000		
1917.....	32	2,000,000,000	+800,000,000	+67
1918.....	51	3,200,000,000	+1,200,000,000	+60
1919.....	57	3,100,000,000	-100,000,000	-3
1920.....	56	4,200,000,000	+1,100,000,000	+35
1921.....	59	3,725,000,000	-475,000,000	-11

Power-site reserves, in acres.

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction.]

State.	Reserved prior to July 1, 1921.	Eliminated prior to July 1, 1921.	Reserves outstanding prior to July 1, 1921.	Reserved during fiscal year.	Eliminated during fiscal year.	Reserves outstanding June 30, 1922.
Alabama.....	422		422	327		749
Alaska.....	131,587	520	131,067	20,178		151,245
Arizona.....	944,369	105,194	839,175	158,870		998,045
Arkansas.....	26,081		26,081	2,388		28,469
California.....	603,536	17,994	585,542	213,909	258	799,008
Colorado.....	305,965	32,615	272,750	18,387	15,631	275,505
Florida.....	486		486			486
Idaho.....	396,067	132,657	263,410	3,536	32,694	234,252
Michigan.....	1,240		1,240			1,240
Minnesota.....	12,841	532	12,309			12,309
Montana.....	241,619	67,500	174,119	9,200	10,626	172,693
Nebraska.....	761		761			761
Nevada.....	27,875	280	27,595	244,721		272,316
New Mexico.....	214,422	6,239	208,183	759	298	208,644
Oregon.....	503,351	47,795	455,556	3,495	17,488	441,563
South Dakota.....	12		12			12
Utah.....	586,394	112,939	473,455	2,278	4,373	471,360
Washington.....	157,546	35,296	122,250	18,544	545	140,249
Wisconsin.....	1,096		1,096		226	870
Wyoming.....	195,753	67,546	128,207	21,170		149,377
	4,350,823	627,107	3,723,716	717,662	82,139	4,350,239

Summary of outstanding water resources and agricultural withdrawals and classifications, June 30, 1922, in acres.

State.	Power reserves.				
	Withdrawals.	Classifications.	Designations. ^a	Miscellaneous.	Total.
Alabama.....	120	190		439	749
Alaska.....	93,415	1,183		56,647	151,245
Arizona.....	302,208	151	528,245	167,441	998,045
Arkansas.....	22,354	1,590		4,525	28,469
California.....	297,105	24,605		477,383	799,008
Colorado.....	252,510	3,652		19,344	275,505
Florida.....				486	486
Idaho.....	231,555	399		2,308	234,252
Michigan.....	1,240				1,240
Minnesota.....	12,309				12,309
Montana.....	148,197	5,218		19,278	172,693
Nebraska.....	761				761
Nevada.....	27,543			244,773	272,316
New Mexico.....	65,483		143,161		208,644
Oregon.....	415,180	1,242	15,891	9,250	441,563
South Dakota.....				12	12
Utah.....	450,770	1,792		18,798	471,360
Washington.....	114,170	5,182		20,897	140,249
Wisconsin.....				870	870
Wyoming.....	88,691	20,351		40,335	149,377
	2,523,611	65,545	687,297	1,062,786	4,350,239

^a Designated and not otherwise withdrawn.

Summary of outstanding water resources, etc.—Continued.

State.	Reservoir with-drawals.	Public water with-drawals.	Stock-raising homestead designations.	Enlarged homestead designations.	Ground-water reclamation designations.
Arizona.....	23,040	13,951	12,867,276	25,607,205	.....
Kansas.....	.....	.....	1,120	.....	.....
Florida.....	1,160	67,788	7,381,667	12,744,281	.....
Colorado.....	1,728	1,820	7,080,227	32,577,537	.....
Idaho.....	.....	12,120	4,873,575	12,970,976	.....
Nebraska.....	.....	.....	101,434	637,734	.....
Michigan.....	.....	.....	2,831	.....	.....
Montana.....	9,080	7,199	14,239,532	52,857,424	.....
Nebraska.....	.....	.....	136,135	.....	.....
Nevada.....	.....	10,431	415,509	46,450,478	1,100,000
New Mexico.....	.....	6,281	30,505,500	42,808,207	.....
North Dakota.....	1,569	.....	329,832	12,259,022	.....
Oklahoma.....	.....	.....	61,151	.....	.....
Oregon.....	10,619	13,201	5,899,111	20,179,812	.....
South Dakota.....	.....	240	6,393,257	15,973,095	.....
Texas.....	80	34,526	900,528	10,479,289	.....
Washington.....	35,943	920	591,289	6,330,033	.....
Wyoming.....	1,714	82,185	18,867,903	28,643,472	.....
	84,933	250,662	110,738,807	320,518,565	1,100,000

Includes 559,554 acres in Idaho and 1,562,614 acres in Utah designated under nonresidence provisions of the acts.

IRRIGATION SECTION.

The primary work of the irrigation section is classification of lands with respect to irrigability under the enlarged and stock-raising homestead and Nevada ground-water reclamation acts. In the main, the thousands of applications received are disposed of on the basis of office information recorded in the inventory of water resources and other convenient aids to ready reference. Broad areal classification has been made as far as practicable, and in consequence the number of incoming cases has been reduced to a minimum. Cases that can not be handled otherwise are listed for field examination and report by the water-resources branch. Additional broad field studies in critical areas are planned for execution by the field branches when required and financed by allotments from the funds of the board. During the year such studies were made in the Arkansas River valley, Colorado, the Casa Grande Valley, Arizona, and the Uinta basin, Utah, and an extended survey of irrigation possibilities was made in Nevada.

The section also makes reports on the sufficiency of water supply and general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of the public-land laws, and it initiates the withdrawal of lands for reservoir sites.

The tables relating to enlarged and stock-raising homestead designations and the general summary of cases show briefly the results of many features of the work of the section. During the year an area of 382,320 acres in Nevada was designated under the ground-water reclamation act, and 1,160 acres in California was included in reservoir-site withdrawals.

GRAZING SECTION.

The stock-raising homestead law requires that prior to entry under its terms the land shall be classified as nontimbered, nonirrigable, suitable chiefly for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family. The grazing section of the board determines what lands shall be so classified, except as to irrigability, which is determined

by the irrigation section. The nature of the classification is so complex that in many extensive areas detailed information concerning the particular tract applied for is essential to proper classification. Field examination of individual tracts by the water-resources branch is therefore planned by the grazing section and financed by allotments from the board's funds. Broad areal classification, after general reconnaissance, is applied wherever practicable, thus reducing the number of detailed field investigations to a minimum.

After struggling since 1917 to overcome the handicap of an almost total lack of specific information and to report on the many thousands of applications filed soon after the passage of the act, the grazing section has finally made its work essentially current.

Reservation and restoration of tracts valuable for watering stock is also a duty of this section. During the year additions to public water reserves embraced 285 acres in Arizona, 8,192 acres in California, 240 acres in Idaho, 1,103 acres in Nevada, 80 acres in New Mexico, 1,317 acres in Oregon, 2,570 acres in Utah, and 40 acres in Wyoming, and the cancellations of such reserves included 585 acres in California, 240 acres in Montana, 45 acres in Nevada, 200 acres in New Mexico, 900 acres in Oregon, 3,871 acres in Utah, and 2,242 acres in Wyoming. The areas remaining reserved as public watering places in the several States at the end of the year are shown in the table of outstanding water resources and agricultural withdrawals and classifications, which also shows the outstanding designations under the stock-raising homestead act.

The general summary of cases and the summary of stock-raising homestead designations show in detail other features of the progress of the work of this section.

Summary of enlarged-homestead designations, in acres.

[Areas classified as arid and nonirrigable, residence by entrymen required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 132), applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat. 953), applicable to Kansas; act of Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho).]

State.	Designations prior to July 1, 1921.	Cancellations prior to July 1, 1921.	Designations outstanding prior to July 1, 1921.	Designa- tions during fiscal year.	Cancellations dur- ing fiscal year.	Designations outstanding June 30, 1922.
Arizona.....	30,704,092	5,409,474	25,294,618	312,587	.....	25,607,205
California.....	11,806,396	226,480	11,579,916	1,176,205	11,849	12,744,281
Colorado.....	32,157,584	184,320	31,973,264	604,913	640	32,577,537
Idaho:						
Total.....	13,256,029	444,125	12,811,904	168,352	a 9,280	12,970,976
Nonresidence.....	552,787	4,233	548,554	11,000	.....	559,554
Kansas.....	605,734	.....	605,734	32,000	.....	637,734
Montana.....	52,619,721	244,282	52,375,439	481,985	.....	52,857,424
Nevada.....	49,948,295	3,564,797	46,383,498	66,980	.....	46,450,478
New Mexico.....	42,980,781	227,732	42,753,049	55,158	.....	42,808,207
North Dakota.....	12,231,960	3,848	12,228,112	30,910	.....	12,259,022
Oregon.....	21,054,769	984,494	20,070,275	109,745	208	20,179,512
South Dakota.....	16,260,175	348,170	15,912,005	61,090	.....	15,973,095
Utah:						
Total.....	10,583,974	350,415	10,233,559	265,290	b 19,560	10,478,289
Nonresidence.....	1,565,174	12,320	1,552,854	19,280	9,520	1,562,614
Washington.....	6,501,725	251,842	6,249,883	80,150	.....	6,330,033
Wyoming.....	28,214,138	136,256	28,077,882	585,590	.....	28,663,472
	328,925,373	12,396,235	316,529,138	4,030,955	41,528	320,518,665

a 9,280 acres previously designated under secs. 1-5, now designated under sec. 6.

b 9,400 acres previously designated under secs. 1-5, now designated under sec. 6.

Summary of stock-raising homestead designations, in acres.

is classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising ge crops, and of such character that 640 acres is reasonably required for the port of a family. Act of December 29, 1916 (39 Stat. 862).]

State.	Designations prior to July 1, 1921.	Cancellations prior to July 1, 1921.	Designations outstanding prior to July 1, 1921.	Designations during fiscal year.	Cancellations during fiscal year.	Designations outstanding June 30, 1922.
Ala.	13,609,930	832,040	12,777,890	89,348		12,867,236
Ariz.	240		240	880		1,120
Cal.	7,354,132		7,354,132	27,535		7,381,667
Col.	6,115,441	8,240	6,107,201	973,666	640	7,080,227
Idaho	4,451,904	574	4,451,330	422,745	400	4,873,575
Mont.	93,114		93,114	8,320		101,434
Nev.	911		911	1,920		2,831
N.M.	13,735,267	16,000	13,719,267	520,285		14,239,552
Okla.	124,778		124,778	11,357		136,135
Tex.	199,849		199,849	218,460	2,800	415,609
Utah	29,896,683		29,896,683	610,417	600	30,506,500
Dakota	310,254		310,254	19,578		329,832
Wyo.	49,871		49,741	11,280		61,151
Mont.	5,405,301	640	5,404,661	494,858	208	5,899,111
Dakota	6,267,477	320	6,267,157	126,170	70	6,393,257
Idaho	717,060	240	716,820	273,708		990,528
Mont.	360,220		360,220	232,203	1,134	591,289
Idaho	18,129,266	3,060	18,126,206	741,717		18,867,903
	106,821,598	861,334	106,960,264	4,784,485	5,852	110,738,997

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 22,697 pages of manuscript were edited and prepared for printing, and proof sheets comprising 2,121 galley proofs 11,487 page proofs were read and corrected. Indexes were prepared for 19 publications, covering 4,600 pages. Copy and proof or gals for 1,958 pages of multigraph and mimeograph matter were . The publications of the year are listed and abstracted on s 4-10.

At the end of the fiscal year six persons were employed in this on. The water-resources branch has continued to render special tance in preparing copy and reading proof.

SECTION OF ILLUSTRATIONS.

The number of illustrations prepared was 2,565, including 215 ellaneous maps, 574 sections and diagrams, 402 photographs, and t paleontologic drawings; 302 miscellaneous jobs were also done he section. The illustrations transmitted to accompany manu-ts numbered 1,716, to be reproduced by chromolithography. olithography, halftone, zinc etching, and cuts already ened. The number of proofs received and examined was 1,663. he end of the year material for illustrating 44 reports was on l. During the year the force has been reduced by one death and resignation; one of the vacancies was filled by transfer from an section of the Survey, and the force now includes 11 persons.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

The geologic maps and other illustrations for 42 reports, 7 folios of the Geologic Atlas of the United States, and Part II of the World Atlas of Commercial Geology were examined and edited during the year. Part II of the World Atlas, comprising 10 maps printed in colors, with accompanying text, was completed and published. One geologic folio (No. 213, New Athens-Okawville, Ill.) was completed and published. Three folios (Raton-Brilliant-Koehler, N. Mex.-Colo., Hot Springs, Ark., and Ray, Ariz.) were well advanced and the maps printed. The maps of the Central Black Hills (S. Dak.) and Carlyle-Centralia (Ill.) folios were in color proof, approved for printing. The Riddle (Oreg.) folio was prepared and made ready for engraving.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

During the year 62 topographic maps were edited and transmitted for engraving, 227 published topographic maps were edited for reprint, and 294 maps were edited as illustrations for Survey reports, a total of 583 maps edited. The proofs read in first, second, and combined proof for new topographic maps numbered 95, and plate proof was read for corrections to 166 reprinted topographic maps. Proofs were corrected for 98 maps reproduced by photolithography. At the end of the year 69 new topographic maps were in process of engraving and printing. Index maps for 16 State circulars were revised and proofs corrected. A new edition of the topographic and geologic index map of the United States was prepared and printed on a scale of 1:2,500,000. (See also "Topographic branch," pp. 46-47.)

DIVISION OF DISTRIBUTION.

A total of 457 publications, comprising 157 new books and pamphlets, 1 new geologic folio, Part II of the World Atlas of Commercial Geology, 7 reprinted books and pamphlets, 2 new geologic maps, 90 new or revised topographic maps, 198 reprinted topographic maps, and 1 list of publications, were received by the division of distribution during the year. A number of special pamphlets and forms prepared for administrative use were also delivered and distributed. The total units of all publications received numbered 479,117 books and pamphlets, 4,258 geologic folios, 5,010 copies of Part II of the World Atlas, 132 geologic maps, and 969,981 topographic and other maps, a grand total of 1,458,498.

The division distributed 590,284 books, 8,734 folios, 3,099 copies of the World Atlas (1,103 of Part I and 1,996 of Part II), and 727,477 maps, a total of 1,329,594, of which 6,346 folios, 1,907 copies of the World Atlas (788 of Part I and 1,119 of Part II), and 594,217 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$42,078.99, including \$38,838.84 for topographic and geologic maps, \$872.75 for geologic folios, and \$2,367.40 for copies of the World Atlas. The division received and answered 97,607 letters.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS.

During the fiscal year 70 new topographic maps were engraved and printed. In addition to these, 22 new topographic maps were engraved, but the printing was not completed by June 30. A strip to complete the map of Lawrence County, Mo., was also engraved, 10 prints were required. Engraving on 14 more new topographic maps was nearly completed. Twenty new maps were photolithographed and printed, making a total of 90 new maps printed and delivered.

Corrections were engraved on the plates of 222 maps. Reprint editions of 181 topographic maps showing corrections and of 17 corrected State and other photolithographed maps were also printed and delivered.

New and reprinted maps 288 different editions, amounting to 111 copies, were delivered to the map room.

A new geologic folio was published, the edition amounting to 100 copies. Extra geologic maps of this folio to the number of 100 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING.

A large amount of work was also done for the Government Printing Office, various branches of the War Department, Federal Board of Vocational Education, Veterans' Bureau, Department of State, Army Department, Department of Labor, Navy Department, Department of Justice, International Boundary Commission, Department of the Interior, Reclamation Service, General Land Office, Bureau of Mines, Office of Indian Affairs, National Park Service, Bureau of Standards, Forest Service, Federal Power Commission, Interstate Commerce Commission, Alaskan Engineering Commission, United States Tariff Commission, Weather Bureau, Bureau of Public Roads, Bureau of Markets and Crop Estimates, and States Relations Service. This work for other branches of the Government included many reprint editions and amounted to \$106,000, for which the appropriation for engraving and photolithographic maps was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for private firms, State organizations, and colleges and the money received in payment for the work, \$350.67, was paid into the Treasury of the United States to be credited to miscellaneous receipts. Transfer impressions to the number of 491 were made during the year, including 230 furnished to contracting printers for acquisition of the Government Printing Office, 161 furnished to State firms and institutions, and 100 furnished under cooperative arrangements without charge to various State geological surveys.

During the year Part II of the World Atlas of Commercial Geography and the large irrigation and relief map of California were completed, as well as a large amount of miscellaneous work relating to map publications of the Geological Survey.

Contract and miscellaneous printing of all kinds, 2,442,227 copies, were printed. Including topographic maps and geologic maps, a grand total of 3,416,598 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 12,819 negatives (1,289 wet, 2,361 dry, 319 paper, 4,734 field negatives developed, and 4,116 photolithographic), 907 lantern slides, 90,629 prints (67,219 maps and diagrams, 16,561 photographs for illustrations, and 6,849 rectigraphs), 3,664 zinc plates, 158 zinc etchings, 46 celluloid prints, 263 lantern slides colored, and 993 prints mounted.

ADMINISTRATIVE BRANCH.**EXECUTIVE DIVISION.**

The work of the executive division was of the same general character as during the fiscal year 1921.

Mails, files, and records.—During the year 148,015 pieces of mail, of which 2,508 were registered, were opened and referred; 5,000 letters and cards were received in connection with revisions of mailing lists. In addition 174,800 letters were received direct by the other divisions, making a total of 327,815, a decrease of 6 per cent compared with 1921. Of the letters opened in this division, 21,955 contained \$41,889.38 remitted for Survey publications, a decrease of 10 per cent in number of letters and of \$2,330.02 in amount compared with 1921. The number of ordinary letters mailed through the division was 108,065, of registered letters and packages 21,436, and of form letters and cards, etc. (addressograph section) 600,000. In addition 299,200 pieces of mail were sent out direct from other divisions. The total number of outgoing pieces of mail for the Geological Survey was 1,028,701.

Freight and express.—During the year 2,000 pieces of freight and express were handled, 954 outgoing and 1,046 incoming.

Personnel.—The roll of Secretary's appointees numbered 877 at the end of the fiscal year, 122 less than at the end of 1921. The total number of changes in the personnel was 506, which included 74 appointments and 196 separations (4 deaths).

During the calendar year 18,170 days of annual leave and 4,965 days of sick leave were granted, being 68 per cent of the amount of the annual leave which could have been taken and 18½ per cent of the amount of sick leave which it would have been possible to grant to an average of 893 employees; 12,366 days of leave without pay and furlough were also granted.

The personnel work and the recording, referring, reviewing, filing, and mailing of correspondence required the service of 17 clerks. On June 30, 1922, this number was reduced to 13.

DIVISION OF SCIENTIFIC AND TECHNICAL EQUIPMENT.

The requisitions on the division of scientific and technical equipment during the year numbered 1,286, of which 1,254 were completed. Registration of instruments was checked and errors corrected. The principal correction was in aneroid barometers, which were found to be very irregular and showed improper handling. An exhibition of the barometer was arranged, and an effort was made to educate all users in the proper care of this delicate instrument. An apparatus for determining the flow of oil, salt water, and fresh water through oil and sand was devised. A system for the setting of platinum

cross wires was perfected and is now being used for the Geological Survey and Reclamation Service at a material saving. Previously only one shop in the country did work of this sort, and naturally its charges were high. A noncorrosive and nonmagnetic bomb to withstand a pressure of 3,000 pounds was made. Improvements on deep-well apparatus and many other devices were accomplished at much less cost than would have been possible in an outside shop.

LIBRARY.

In the library the receipts numbered 1,598 books, 14,572 periodicals and pamphlets, and 653 maps; 1,401 books were bound. The record of readers and visitors is 13,369, and the loans for outside use 7,736 books and 426 maps. Continued calls are received from libraries in other parts of the country for the loan of publications known to be available only in this library, such as scarce foreign governmental reports on geology, foreign technical and scientific periodicals, and foreign maps. New cards to the number of 7,396 were added to the catalog, and 576 catalog entries were prepared and submitted to the Library of Congress for printing. Over 3,000 letters were written, largely concerning the exchange of publications; this correspondence involved the translation of hundreds of letters in foreign languages. Foreign articles and letters to the number of 265 were translated for other divisions of the Survey. The bibliography of North American geology for 1919 and 1920 was prepared and submitted for publication. The small staff of the library did its best to make this great, highly special, and almost priceless collection of books and maps fill the full measure of service which it should render to students and specialists.

DIVISION OF ACCOUNTS.

Condensed statements covering the expenditures from Federal funds during the year are given on pages 78-79. The amounts contributed by States for cooperative work are set forth on pages 43, 53-54.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1922.^a

Appropriation.	Amount of appropriation.	Transferred to the general reserve as a saving.	Funds a valuable.				Expenditures.			Balance.	
			Repayments on account of work performed.			Total.	Disbursements.	Outstand- ing liabilities.	Total.		
			Net amount available for expenditures.	For other Government establishments.							For other Geological Survey units.
				Made.	To be made.						
	\$22,180.00	\$1,283.33	\$20,876.67			\$20,876.67	\$20,876.67		\$20,876.67		
Salaries, office of Director.	28,900.00		28,900.00			28,900.00	28,900.00		28,900.00		
Salaries, scientific assistants.	180,000.00	2,700.00	177,300.00	\$21,051.82	\$5,951.36	\$5,099.19	209,402.37	206,642.82	27,470.80	\$238.75	
Gaging streams, etc.	40,000.00	600.00	39,400.00			70.10	39,479.10	38,821.77	584.84	72.49	
Chemical and physical re- searches.	18,280.00		18,280.00		180.00		18,460.00	18,448.93	18,448.93	11.07	
Preparation of illustrations.	125,000.00	1,800.00	123,200.00			111.92	123,311.92	121,993.55	1,160.25	188.02	
Mineral resources of the United States.	140,000.00	15,000.00	125,000.00	84,024.50	10,862.96	14,540.96	234,428.32	216,372.16	12,740.48	5,306.68	
Geologic maps of the United States.	2,000.00		2,000.00			1,755.71	2,000.00	1,755.71	244.29		
Books for the library.	330,000.00	4,800.00	325,200.00	37,438.34	12,387.53	15,116.05	390,136.92	386,507.64	2,636.69	986.00	
Topographic surveys.	352,000.00	5,100.00	346,900.00	6,127.35	811.32	761.02	355,096.69	340,188.37	12,980.24	1,921.08	
Geologic surveys.	75,000.00		75,000.00				75,000.00	70,143.09	4,678.34	1,181.67	
Mineral resources of Alaska.	300,000.00	2,000.00	298,000.00	2,562.27	260.00	1,368.73	302,221.00	268,694.30	2,897.85	628.85	
Classification of lands.											
	1,614,340.00	33,283.33	1,581,056.67	151,702.28	30,453.07	37,106.97	1,800,318.99	1,750,345.01	40,408.76	9,564.20	

^a In addition to these appropriations, \$140,000 for Survey publications was contained in the appropriation for printing and binding but not disbursed by Survey officials. There was also an allotment of \$10,000 for miscellaneous printing and binding from the Interior Department appropriation for that purpose, and an allotment of \$7,523.36 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

^b Included in this amount is \$37,106.97 covering work performed by Survey units for other Survey units, necessarily reported in combining totals but otherwise a duplication.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1922.

Appropriation.	Total.	Salaries and wages.	Transportation of persons and things.	Provisions, subsistence and support of persons.	Forage, subsistence and support of animals.	Printing, engraving, lithographing, etc.	Special and miscellaneous service.	Materials, miscellaneous supplies, etc.	Stationery, drafting, etc., supplies.	Equipment, (including live stock).	Maintenance, operation, and repair of passenger-carrying vehicles.	Hire of motor-propelled and horse-drawn passenger-carrying vehicles.	Purchase of motor-propelled passenger-carrying vehicles.
Salaries, office of Director.	\$20,875.67	\$20,875.67											
Salaries, scientific assistants.	28,900.00	28,900.00											
Gaging streams, etc.	200,113.62	160,983.73	\$13,183.73	\$6,671.67	\$9.20	\$2,136.42	\$6,137.77	\$2,559.21	\$1,177.34	\$13,548.10	\$307.46	\$495.76	\$1,912.25
Chemical and physical researches.	39,408.61	29,970.78	491.40	2,294.93		54.63	2,292.73	1,102.64	123.96	2,007.31	840.48	143.75	
Preparation of illustrations.	18,448.98	18,078.06				242.68	74.75	14.44	39.00				
Mineral resources of the United States.	123,153.90	113,060.54	3,076.87	2,005.07	.75	1,118.36	2,975.45	12.96	294.22	605.68			
Geologic maps of the United States.	229,121.64	169,811.06	510.97	233.91		81.52	5,344.78	7,920.91	36,005.66	9,156.41		56.40	
Books for the library.	2,000.00									2,000.00			
Topographic surveys.	389,144.23	288,798.00	21,252.64	46,057.43	4,246.42	6,766.50	7,190.61	1,015.26	760.98	8,238.14	4,837.82	952.43	
Geologic surveys.	353,178.61	290,266.62	14,977.54	16,335.64	808.92	4,906.06	11,675.36	1,445.13	1,047.36	17,163.96	928.42	959.60	2,124.00
Mineral resources of Alaska.	74,819.43	52,530.70	10,321.97	2,769.33	365.11	1,070.42	6,765.27	219.20	203.04	613.39			
Classification of lands.	301,562.15	220,156.54	14,801.88	24,579.06	1,764.23	4,480.74	4,764.36	890.05	1,016.22	18,677.19	222.14	256.74	
	1,760,754.79	1,394,435.69	78,616.99	100,448.04	7,184.63	20,877.33	47,288.08	15,186.80	40,769.80	71,999.18	7,156.32	2,835.66	4,036.25

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OF THE
DIRECTOR OF THE UNITED STATES
GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR

ENDING JUNE 30

1923





DEPARTMENT OF THE INTERIOR

HUBERT WORK, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

FORTY-FOURTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES
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TO THE

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FOR THE FISCAL YEAR

ENDED JUNE 30

1923



WASHINGTON

GOVERNMENT PRINTING OFFICE

1923

Directors of the U. S. Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894

GEORGE OTIS SMITH, 1907-

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ILLUSTRATION.

PLATE I. Areas covered by topographic surveys made by United States Geological Survey prior to July 1, 1922.....

N. S. East.
97.
1-30-1927

FORTY-FOURTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

APPROPRIATIONS.

The direct appropriations for the work under the Geological Survey for the fiscal year 1922 comprised items amounting to \$1,450,940. In addition \$119,000, to be disbursed under the direction of the Public Printer, was appropriated for printing the reports of the Survey, and allotments of \$8,000 and \$5,050.93 for miscellaneous printing and binding and miscellaneous supplies, respectively, were made from Interior Department appropriations.

GENERAL SUMMARY.

The range of the Geological Survey's activities is shown by the following outline of the work done during the year, which is set forth in detail in the reports of the several branches. During the fiscal year 1923 the Survey

Made geologic surveys in 32 States, mapping the geology and determining the mineral resources and geologic history.

Studied ore deposits in 10 States and prepared or brought to different stages of completion 16 reports on ore deposits.

Made geologic studies in 8 States to determine the prospects of obtaining oil and gas and prepared or partly prepared 20 reports showing the results of such studies.

Made laboratory researches to determine the sources of petroleum, the mode of its formation from them, and the features of oil sands, such as texture and porosity, that are conducive to the accumulation of oil.

Published maps of Kentucky, West Virginia, and southern California showing oil and gas fields, pipe lines, and refineries, and a similar map on a smaller scale of the United States.

Examined and sampled coal beds in 9 States for the classification of lands and for the administration of the land-leasing act, as well as to guide future development, and prepared or has in preparation 6 reports on coal fields.

Made geologic examinations of sites for dams and reservoirs in 6 States in cooperation with the Reclamation Service to determine the strength, tightness, and other features of the rocks.

Continued cooperation with the Forest Service, the General Land Office, and the Indian Office in examinations of public lands, especially to determine whether they contain oil, gas, or other mineral deposits.

Assisted the United States Coal Commission by furnishing statistical records and expert advice concerning certain phases of the coal industry.

Made cooperative field studies of ore deposits, coal beds, and geologic formations in Virginia, North Carolina, Alabama, and Idaho and completed, in cooperation with the State, the manuscript of a geologic map of Arizona.

Identified thousands of fossils to determine their geologic age and thus the stratigraphic horizons or probable depths at which they were found, in order

that they may be made serviceable to drillers for oil and gas and others, as well as in general geologic research.

Mapped and examined geologically parts of the San Andreas rift zone in California to determine the occurrence of earthquakes in this zone in recent geologic time.

Published more than 40 reports on the geologic features and mineral resources of areas in different parts of the United States.

Examined the mineral resources in Alaska adjacent to the Alaska Railroad, as well as those in the Chitina Valley, in the vicinity of Fairbanks, in the Wrangell and Chandalar districts, and in the Prince William Sound region, and determined the general condition of the mining industry in the Territory.

Made a reconnaissance geologic and topographic survey of the oil fields of the Alaska Peninsula.

Prepared in part or completely reports on the Juneau and the Ketchikan districts and the Ruby-Kuskokwim region and continued revision of the geographic dictionary of Alaska.

Began, at the request of the Navy Department, the investigation of the oil resources of Naval Petroleum Reserve No. 4, on the Arctic coast of Alaska.

Published the annual report on the mineral resources of Alaska for 1920, giving an account of the investigations made and of the state of the mining industry during the year, and four advance chapters of the similar report for 1921, as well as reports on deposits of tin ore on York Peninsula, on deposits of chromite on Kenai Peninsula, and on the geology and copper deposits of the Kotsina-Kuskulana district.

Published a new map of Alaska, in four colors.

Examined and identified more than 2,000 specimens of rocks and minerals and made nearly 700 quantitative analyses of rocks and minerals for use in geologic investigations.

Continued studies of the physical and chemical character of sediments and of the principles of sedimentation, making in this study analyses of 68 samples of ocean sediments.

Made laboratory studies of the chemical changes by which copper is formed in nature.

Determined the temperature of 128 springs and geysers in Yellowstone National Park and the temperature in deep wells in Pennsylvania, Wyoming, and Oregon.

Prepared papers on isostasy and on mountain building through isostatic readjustment, on the inorganic constituents of marine invertebrates, and on sodium sulphate, and has 11 other chemical reports in various stages of preparation.

Continued the collection of the annual statistics of the mineral production in the United States and cooperated in this work with 16 States.

Issued weekly reports on the production of coal and monthly reports on the production of petroleum and cement.

Prepared special statistical reports regarding various mineral commodities for several other Government agencies, including the Senate Committee on Manufactures, the President's Conference on Unemployment, and the Fuel Distributor.

Continued to compile information showing the mineral production of other countries, especially the production of coal and petroleum.

Made topographic surveys in 22 States, completing new surveys of areas aggregating more than 13,000 square miles and resurveying areas aggregating more than 1,700 square miles.

In performing this work ran 6,413 miles of primary levels, established 1,533 permanent bench marks, occupied 102 and marked 83 triangulation stations, and ran 2,314 miles of lines of primary traverse.

Mapped areas in Hawaii aggregating 559 square miles, ran 65 miles of primary levels, and established 21 bench marks, all in cooperation with the Territory.

Made 564 linear miles of river surveys in the United States to determine stream profiles, including surveys to determine the feasibility of storing and diverting waters for use in irrigation and especially for the generation of power, and published maps showing the plan and profile of parts of Colorado River.

Prepared shaded relief maps of Ohio, West Virginia, and Grand Canyon of the Colorado and of 14 smaller areas, including a map of the country around Washington, D. C., bearing on the back a descriptive text.

Continued the compilation of the base of the United States portion of the international map of the world in cooperation with the Bureau of Public Roads. Maintained cooperation in topographic work with the Coast and Geodetic Survey, the Forest Service, the Reclamation Service, and the Engineer Corps of the Army.

Published 73 standard topographic maps of quadrangles in the United States and 14 State maps.

Continued measurements of the flow of streams at about 1,600 stations in the United States and Hawaii to determine quantities of water available for various purposes and to provide data for use in work to be done to prevent floods, performing part of the work in cooperation with other Government organizations and with 32 States and Hawaii.

Made investigations of ground water in 16 States and in Hawaii, cooperating in this work with 6 States and Hawaii.

Published 15 reports relating to surface water, 3 reports relating to ground water, and a comprehensive report on hydroelectric power systems of California and adjacent States.

Made laboratory studies of methods of water analysis and analyzed 275 samples of waters collected at different places in the United States to determine their mineral quality so far as it may affect their use in manufacturing industries, and prepared and published a report showing the chemical character of the water of public supplies used by nearly 30,000,000 persons in 307 cities in the United States.

Continued the preparation of monthly reports showing the production of electricity and the consumption of fuel by public-utility power plants and the preparation of State maps showing the location of power stations and transmission lines used in public service, as well as reports showing the stock of coal on hand from time to time at electric public-utility plants.

Made field examinations in 14 States of lands subject to entry under the enlarged-homestead and stock-raising homestead laws.

Made field examinations of streams and lands in 14 States to enable their classification with respect to their value for water power or irrigation.

Prepared or has in preparation reports on ground water in areas in 10 States. Reported on more than 15,000 cases arising under the administration of the public-land laws.

Classified 408,123 acres with respect to coal and 162,949 acres with respect to petroleum and increased the gross area of defined oil and gas fields by 989 acres.

Reported on 5,162 applications for permits, leases, or patents involving public mineral lands under the leasing laws.

Recommended the addition of 339,209 acres to the power-site reserves and the elimination of 30,119 acres.

Recommended the designation of 2,078,818 acres of land as available for settlement under the enlarged-homestead acts and the cancellation of designations involving 26,216 acres.

Recommended the designation of 2,252,469 acres of stock-raising homestead land and the cancellation of designations involving 5,755 acres.

Edited and otherwise prepared for printing 24,473 pages of manuscript, read and corrected 2,748 galley proofs and 20,628 page proofs, and prepared indexes for 55 reports covering 12,985 pages.

Prepared for reproduction in reports more than 4,000 illustrations and prepared geologic maps, structure sections, and other illustrations for 6 geologic folios.

Edited and transmitted to engraver 70 topographic maps, edited for engraving reprint 200 topographic and other maps and profile river-survey sheets, as well as 195 maps for incorporation in reports, and read more than 600 proofs of topographic maps.

Published 482,591 copies of books and pamphlets, 3,551 copies of geologic folios, 3,000 copies of the World Atlas of Commercial Geology, 700 geologic maps, and 1,027,585 copies of topographic and other maps, a grand total of 19,787 publications.

Distributed 470,491 books, 8,262 geologic folios, 1,053 copies of the World Atlas of Commercial Geology, and 741,116 maps, a total of 1,220,992 copies of publications, of which 604,598 were sold.

Printed for other bureaus of the Government nearly 3,000,000 copies of maps, charts, diagrams, etc., costing about \$100,000.

Maintained a photographic laboratory whose output consisted of 13,890 negatives, 671 lantern slides, 120,497 prints, and other material.

Maintained a geologic library, receiving more than 14,000 books, pamphlets, and maps, afforded facilities for more than 13,000 readers, and lent for outside use more than 7,500 books and maps.

Received nearly 340,000 letters, handled more than 1,600 packages or pieces sent by freight or express, incoming and outgoing, and sent out more than 1,400,000 pieces of mail.

MAJOR CHANGES IN ORGANIZATION.

On September 22, 1922, Congress passed an act establishing a commission to inquire fully into the facts relating to the coal industry, with the aim of obtaining advice concerning measures that might be adopted to insure a supply of coal to the industries and to the people generally throughout the country. Because of his position as Director of the Geological Survey, a bureau long and intimately connected with the mining industry, and because he had personally, both as geologist and as administrative officer, given special attention to coal and power problems, Dr. George Otis Smith was named by President Harding as one of the commissioners. This selection necessitated making a choice between the two positions, as according to law two Government positions can not be held by one person at the same time. Doctor Smith decided to accept the commissionership and resigned as Director of the Survey October 31. In reaching this decision he stated that

The opportunity afforded a Survey representative to serve on the United States Coal Commission is not only a deserved honor to the Survey but also a desired chance to make the largest use of Survey data and personnel to the advantage of the public.

The Coal Commission expires by law September 22, 1923, and as both the President and the Secretary of the Interior desired to have Doctor Smith return and continue his effective administration of the Geological Survey after the completion of his duties as commissioner, the position of Director of the Geological Survey was not filled, but Philip S. Smith, a geologist of the Survey, who since January 11, 1915, had served during the absence of the Director as Acting Director, was continued in that capacity.

On November 16 David White completed 10 years of service as chief geologist. His contribution to the administration of the Survey was made at the expense of his own scientific work, even though he thereby increased the scientific value of the work of his associates. It seemed fair that his oft-repeated request for permission to return to his own geologic studies should be granted, not only to gratify the natural desire of an investigator who had laid aside research problems, one after another, but also to promote the advancement of the science of geology. The return of Mr. White to productive research suggests anew the sacrifice involved in the administration of scientific work. Administration by scientists is the keynote of the Survey's policy, yet the intellectual cost involved in this drafting of its best investigators must be kept down to a minimum.

W. C. Mendenhall, for more than 10 years the geologist in charge of the land-classification board, succeeded Mr. White as chief geologist. Mr. Mendenhall's 28 years' service in the Survey as assistant geologist and geologist comprised field experience extending from the

southern Appalachians to Alaska, and he brings to his new task a broad sympathy with the technical and scientific problems that will come under his direction, as well as ripe experience in administration.

Mr. Mendenhall was succeeded as chief of the land-classification board by Herman Stabler, his close associate in that branch during the last 10 years. Mr. Stabler's demonstrated capacity as a hydraulic engineer and his close personal contact with the many problems relating to the application and utilization of water, especially in its relation to the administration of the public-land laws, assures the continuance of the successful application of geologic and engineering facts and principles to public-land administration.

NECROLOGY.

Rollin D. Salisbury, geologist of the Geological Survey and head of the department of geology, University of Chicago, died at Chicago, Ill., August 15, 1922. Professor Salisbury was a distinguished figure in American geology through his personal investigations, chiefly in the field of geographic and glacial geology, and through the inspiration he gave to a host of students, many of whom are now among the ablest and soundest of the active investigators in the science of geology.

Barton F. Howe, who had been employed in gaging streams since 1919, was drowned March 3, 1923, in Delaware River near Port Jervis, N. Y., while engaged in official duties.

PUBLICATIONS.

The publications of the year comprised 153 book publications in the regular series, 133 maps, and numerous circulars, lists of publications and maps, advance statements on mineral production, and press bulletins. The total number of pages in the book and map publications was 15,130. Fifteen book publications and 207 maps were reprinted.

Brief notices of the publications in the regular series and of the new maps issued during the year are given in the following pages. These titles constitute the annual record of work accomplished—that is, completed to the extent of making the results available for use.

Forty-third ANNUAL REPORT of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1922. 82 pages, 1 plate.

A detailed account of the work of the Geological Survey during the year. The field work included geologic surveys in 32 States, topographic surveys in 21 States, and investigations of water resources in 40 States, besides work in Alaska and Hawaii. The office work included geologic studies, compilation of mineral statistics, chemical and physical researches, land classification, and the preparation of reports and maps. The Director continued to present the results of the Survey's investigations in popular language by addresses and magazine articles. More than 600,000 books and pamphlets and nearly 730,000 maps were distributed.

PROFESSIONAL PAPER 122. Copper deposits of the Tyrone district, N. Mex., by Sidney Paige. 57 pages, 10 plates, 29 text figures.

The Tyrone district is in Grant County, southwestern New Mexico. Its copper deposits consist of primary ores enriched by descending rain water and impoverished by leaching. This report describes the geology

of the district and the processes that have taken part in the formation of the deposits and contains a brief note on the prospects for additional ore bodies.

PROFESSIONAL PAPER 124. The inorganic constituents of marine invertebrates, second edition, revised and enlarged, by F. W. Clarke and W. C. Wheeler. 64 pages.

A study to determine the substances contributed to marine sediments by corals, mollusks, and other invertebrates.

PROFESSIONAL PAPER 129. Shorter contributions to general geology, 1921. 235 pages, 61 plates, 11 text figures.

Contains 10 papers on stratigraphy, paleontology, and general geology, previously published separately.

PROFESSIONAL PAPER 130. The Laramie flora of the Denver Basin, with a review of the Laramie problem, by F. H. Knowlton. 179 pages, 38 plates, 1 text figure.

Gives the results of investigations of the Laramie formation and its flora and the history of the changes of opinion in respect to beds assigned to this formation. As the final classification of some supposed Laramie areas is still uncertain this account of the flora is confined to an area about which there is little disagreement. Describes 129 forms, 74 of them as new species.

PROFESSIONAL PAPER 131-A. Additions to the flora of the Wilcox group, by E. W. Berry. 21 pages, 18 plates.

Supplements the account of the Wilcox flora published in 1916, describing numerous specimens of petrified wood which show that conifers were much more plentiful in Wilcox time (early Eocene) than had been supposed from the lack of remains of their foliage.

PROFESSIONAL PAPER 131-B. A section of the Paleozoic formations of the Grand Canyon at the Bass trail, by L. F. Noble. 73 pages, 7 plates, 4 text figures.

Although the thick series of horizontal Paleozoic beds that makes up the greater part of the wall of the Grand Canyon is broadly familiar to more people than the beds exposed in any other area in the western United States, the details of the stratigraphy are only imperfectly known. Sections of these formations have been measured at four places in the Grand Canyon National Park, and this paper gives one of these sections in detail, with notes on the other sections.

PROFESSIONAL PAPER 131-C. The shapes of beach pebbles, by C. K. Wentworth. 11 pages, 2 plates, 8 text figures.

Report of a study including measurements of more than 300 beach pebbles at two localities, to determine the shapes produced by wave abrasion.

PROFESSIONAL PAPER 131-D. A geologic reconnaissance in the Gulf Coastal Plain of Texas near the Rio Grande, by A. C. Trowbridge. 33 pages, 6 plates.

Prepared to meet the need for a map and a brief description of the formations on the Texas side of the Rio Grande, to serve as a key for important stratigraphic work in progress both in the United States and in Mexico. Contains also a short paper on new species of Eocene Mollusca from this region, by Julia Gardner.

PROFESSIONAL PAPER 131-E. Preliminary report on fossil vertebrates of the San Pedro Valley, Ariz., with descriptions of new species of Rodentia and Lagomorphia, by J. W. Gidley. 15 pages, 2 plates.

Describes fossil remains that establish the Pliocene age of the sedimentary deposits in San Pedro Valley, which had previously been considered Pleistocene.

PROFESSIONAL PAPER 131-F. Revision of the flora of the Green River formation, with descriptions of new species, by F. H. Knowlton. 52 pages, 5 plates.

The Green River formation extends for about 300 miles southward from the Wind River Mountains, Wyo., in a belt that has a maximum width of 150 miles. It is of economic interest because of its oil shales, which occur over vast areas in Wyoming, Colorado, and Utah. This paper describes the fossil plants of the formation and sets forth the conditions that prevailed during its deposition, as revealed by these plant remains.

PROFESSIONAL PAPER 131-G. Fossil plants from the Tertiary lake beds of south-central Colorado, by F. H. Knowlton. 17 pages, 4 plates.

A preliminary description of the fossil plants found in several lake-bed deposits in the San Juan Mountain region.

PROFESSIONAL PAPER 131-H. The fauna of the so-called Dakota formation of northern central Colorado and its equivalent in southeastern Wyoming, by J. B. Reeside, jr. 20 pages, 6 plates.

The fossil remains described include seven species, besides some undetermined fish scales and bones.

BULLETIN 686-Z. Structure and oil and gas resources of the Osage Reservation, Okla.—Tps. 26 and 27 N., R. 12 E., by P. V. Roundy, K. C. Heald, and G. B. Richardson. 29 pages, 6 plates, 2 text figures.

The final chapter in the series of reports on the Osage Reservation. The structure of the area covered has been worked out in detail.

BULLETIN 686. Structure and oil and gas resources of the Osage Reservation, Okla., by David White and others. 443 pages, 60 plates, 52 text figures.

A consolidation of 26 reports published at intervals between 1918 and 1922, each covering one or more townships in the Osage Reservation.

BULLETIN 707. Guidebook of the western United States; Part E. The Denver & Rio Grande Western Route, by M. R. Campbell. xl, 266 pages; 10 route maps, 96 plates, 63 text figures.

To "know America first" is a patriotic obligation, but to meet this obligation the railroad traveler needs to have his eyes directed toward the more important or essential things within his field of vision and to have much that he sees explained by what is unseen in the swift passage of the train. In this study of geography at first hand the traveler needs a handbook that will answer the questions that come to his mind so readily along the way. To meet this need the Geological Survey planned a series of guidebooks covering the chief railroad routes west of the Mississippi. Four of these guidebooks were issued in 1915 and 1916 and have been widely used; Bulletin 707 is the fifth and covers one of the finest scenic routes of the continent. The route from Denver to Salt Lake City is shown on 10 accurate maps and is described in detail, with a wealth of information concerning the geography, geology, history, and industries of this mountain region.

BULLETIN 708. High-grade clays of the eastern United States, with notes on some western clays, by H. Ries, W. S. Bayley, and others. 328 pages, 30 plates, 38 text figures.

Prior to 1917 large quantities of certain high-grade clays were imported into the United States, and when this country entered the war the problem arose whether similar clays produced in the United States could be obtained in sufficient quantity to meet a much larger demand. This report presents the results of an investigation made to throw light on this problem. The authors conclude that certain industries previously using foreign clays can dispense with them altogether and that others need much less than they had been using. The deposits described comprise clays used for white ware, paper, paint, and linoleum and refractory bond clays.

BULLETIN 709-L. Primary traverse in Virginia, 1916-1918. 100 pages, 1 plate.

BULLETIN 709-M. Triangulation in Arizona, California, and Nevada, 1915-1919. 96 pages, 1 plate.

BULLETIN 709-N. Primary traverse in South Carolina, 1917-1919. 151 pages, 1 plate.

BULLETIN 709-O. Triangulation in New Mexico and Texas, 1915 and 1917. 47 pages, 1 plate.

BULLETIN 709-P. Triangulation in Wyoming and Colorado, 1916 and 1919. 24 pages, 1 plate.

BULLETIN 709-Q. Triangulation and primary traverse in Texas, 1916-1920. 61 pages, 1 plate.

BULLETIN 709-R. Triangulation and primary traverse in North Carolina, 1918. 35 pages, 1 plate.

Seven chapters completing the bulletin on results of triangulation and primary traverse in 1916-1918, in which some later data are included.

BULLETIN 717. Sodium sulphate, its sources and uses, by Roger C. Wells. 47 pages, 13 text figures.

The recent demand for sodium sulphate for export, chiefly for use in making wood pulp for the manufacture of kraft paper, has greatly stimulated the search for deposits of the natural salt in the Western States. This bulletin has been prepared in consequence of numerous requests for information on the sources and uses of sodium sulphate. It gives a summary of the mineralogy of the principal compounds, notes on deposits in the United States and other countries, and other pertinent information.

BULLETIN 720. Economic geology of the Summerfield and Woodsfield quadrangles, Ohio, with descriptions of coal and other mineral resources except oil and gas, by D. D. Condit. 156 pages, 12 plates, 5 text figures.

Describes an area of about 462 square miles in southeastern Ohio; with special reference to its valuable coal resources, the oil and gas having already been described in preliminary reports. The well-known Pittsburgh coal bed occurs in the eastern part of this area but is as yet almost untouched by mining operations. The area contains numerous other coal beds, also some limestone, building stone, clay, and shale. The resources of each township are described separately.

BULLETIN 722. Mineral resources of Alaska; report on progress of investigations in 1920, by A. H. Brooks and others. 266, xiii pages, 3 plates, 19 text figures.

The annual report on geologic work in Alaska; contains papers on the mining industry in general, southeastern Alaska, the Salmon River district, Tuxedni Bay, the upper Kuskokwim region, and Seward Peninsula. These papers have been published separately in advance.

BULLETIN 724. Nitrate deposits in the Amargosa region, southeastern California, by L. F. Noble, G. R. Mansfield, and others. vii, 99 pages, 35 plates, 7 text figures.

During the World War the vital relation of our nitrate supply to the production of explosives and the possibility of interference with our trade connection with Chile, practically the world's sole source of nitrates, made it imperative to develop any domestic deposits that might supply the need. Many deposits of nitrates have been found in the southwestern desert country, and the search stimulated by the war brought out essentially all available evidence concerning such deposits. Attention was centered chiefly on the deposits described in this bulletin. A systematic effort was made to ascertain whether there is any substantial basis for the belief that commercially workable deposits occur in these fields, but the conclusions reached were entirely unfavorable. The quantity of nitrate that could be produced from these deposits would be very small and the cost very high. The bulletin gives in detail the evidence on which these conclusions are based.

BULLETIN 725. Contributions to economic geology (short papers and preliminary reports), 1921; Part I, Metals and nonmetals except fuels. 452 pages, 19 plates, 67 text figures.

A consolidation of papers previously published separately, describing chromite in California, Oregon, Washington, Montana, Pennsylvania, Maryland, and North Carolina; manganese in Montana, Utah, Oregon, Washington, and Oklahoma; tungsten in California, Nevada, Oregon, Utah, Arizona, and New Mexico; pyrite in South Carolina; tin in New Mexico; gold, silver, lead, and zinc in Nevada; and gold, silver, copper, lead, and zinc in Arizona.

BULLETIN 726. Contributions to economic geology (short papers and preliminary reports), 1921; Part II, Mineral fuels. 332 pages, 54 plates, 52 text figures.

The annual bulletin on investigations of mineral fuels. Contains papers on lignite in North Dakota and oil in Oklahoma, Utah, New Mexico, and Texas. These papers were published separately in advance.

BULLETIN 727. Potash in the Greensands of New Jersey, by G. R. Mansfield. 154 pages, 10 plates, 6 text figures.

Describes a belt of greensand marl extending across New Jersey from Sandy Hook to Delaware River. In this belt the greensands contain potash in the mineral glauconite. It is estimated that the quantity of potash that could be mined from the greensands by open-pit methods would be enough to supply the needs of the United States for nearly a thousand years at the rate of importation for the five years 1910-1914. If underground mining should become practicable the available quantity of potash would be enormously increased. The development of a potash industry based on these greensands depends on the ability of the manufacturers to compete with other producers of potash, both foreign and American.

BULLETIN 728. The occurrence and uses of peat in the United States, by E. Soper and C. C. Osborn. 217 pages, 18 plates, 32 text figures.

A report intended to show the method of formation, distribution, quantity, and quality of the peat found in the United States, to indicate the uses for which it is best suited, to point out the possibilities offered by

the commercial utilization of peat, and to serve as a guide for future investigations. Peat is used in the United States chiefly in agriculture, and this use probably offers greater possibilities in this country than in any other.

- BULLETIN 729. Oil shale of the Rocky Mountain region, by Dean E. Winchester. 204 page, 18 plates, 4 text figures.

The racing world demand for oil is bringing nearer the time when the easily extractable petroleum must be supplemented by oil obtained from oil shale by heating. Immense deposits of oil shale occur in the Western States, and much has already been done toward placing the American oil-shale industry on a firm basis, but the industry is still in its early stages, and much more chemical and engineering research is needed to assure success. This bulletin presents the available information concerning the oil shale of the Rocky Mountain region, gives results of distillation tests and a brief description of shale oil, and contains a bibliography of about 1,000 books and articles on oil shale.

- BULLETIN 730-C. The shapes of pebbles, papers by C. K. Wentworth. 24 pages, 2 plates, 17 text figures.

Two brief papers on studies undertaken in an attempt to establish criteria for distinguishing pebbles according to their origin and thus throwing light on their history.

- BULLETIN 730-D. Physiographic provinces and sections in western Oklahoma and adjacent parts of Texas, by N. M. Fenneman. 34 pages, 3 plates, 2 text figures.

Describes a part of the interior plains of the United States, particularly an area just east of the High Plains.

- BULLETIN 730. Contributions to the geography of the United States, 1922. 144 pages, 18 plates, 44 text figures.

The first volume of a new series to be published by the Geological Survey as papers become available. Contains five papers that were published separately in 1922 on the physiography of certain areas in Colorado, Arizona, Oklahoma, and Texas and on a study of the shapes of pebbles.

- BULLETIN 731. Bibliography of North American geology for 1919-20, by J. M. Nickles. 284 pages.

Lists and indexes over 2,100 publications on the geology of North America, Panama, and Hawaii. A continuation of the series of bibliographies, which now cover the years 1732-1920.

- BULLETIN 732. Geology and ore deposits of Shoshone County, Idaho, by J. B. Umpleby and E. L. Jones, jr. 162 pages, 16 plates, 8 text figures.

Shoshone County includes the famous Coeur d'Alene district, the most productive mining district in Idaho and one of the great lead-silver districts of the world. This district, which was described in Professional Paper 62, issued in 1908, has undergone rapid development in the last 15 years, and the present bulletin gives the results of an investigation that throws new light on the origin of the deposits and offers a better basis for intelligent exploration in adjacent areas.

- BULLETIN 733. Geology of the York tin deposits, Alaska, by Edward Steidtmann and S. H. Cathcart. 136 pages, 12 plates, 23 text figures.

The York region is the source of nearly all the tin produced in the United States, which, although the world's leading consumer of tin, yields less than one-half of 1 per cent of the world's production. This report describes the deposits in detail and lays emphasis on the study of the origin of the lode deposits, with a view of aiding in the search for tin in this region.

- BULLETIN 734. Deposits of manganese ore in the Batesville district, Ark., by H. D. Miser, with a chapter on the mining and preparation of the ores by W. R. Crane. 284 pages, 17 plates, 26 text figures.

Another contribution to the inventory of the country's manganese resources resulting from the increased demand and reduced foreign supply during the war. Preliminary reports on this district were published in 1918 and 1920, and the present bulletin gives in detail the information collected. The Batesville deposits have been worked at times since 1849.

- BULLETIN 735-D. Silver enrichment in the San Juan Mountains, Colo., by E. S. Bastin. 65 pages, 19 text figures.

Report on part of a topical study of the enrichment of silver ores in many districts. Concludes that although some of the ores in the San Juan region owe their richness in silver to downward enrichment by percolating solutions, some of the primary ores are rich enough to be profitably mined.

As the primary ores extend to greater depth than the enriched ores, this conclusion offers encouragement to deep mining.

BULLETIN 735-E. Primary native silver ores near Wickenburg, Ariz., and their bearing on the genesis of the silver ores of Cobalt, Ontario, by E. S. Bastin. 25 pages, 14 text figures.

The silver ores of a mine near Wickenburg are of peculiar interest to economic geologists because their principal silver mineral—native silver—is primary, whereas most occurrences of native silver are unquestionably the products of downward enrichment. In some of their associations the Wickenburg ores resemble the famous silver ores of Cobalt, Ontario. This paper sets forth conclusions reached in regard to these ores in the course of a study of silver enrichment in many mining camps of the western United States. The results favor the hypothesis that the rich native silver ores of the Cobalt district are also primary.

BULLETIN 735-F. General features of the brown hematite ores of western North Carolina, by W. S. Bayley. 56 pages, 3 plates, 10 text figures.

The continuous production of brown iron ore in North Carolina during the last five years has attracted attention to the State as a possible source of supply when the demand for such ore becomes more pressing. This paper outlines the general conclusions derived from a study of the ores.

BULLETIN 735-G. General features of the magnetite ores of western North Carolina and eastern Tennessee, by W. S. Bayley. 66 pages, 6 text figures.

The magnetite deposits described have yielded about 1,500,000 tons of iron ore, and some of them were worked as early as 1802 to supply ore for use in Catalan forges. The paper contains maps of the magnetite areas and analyses of the ores.

BULLETIN 735-H. Peridotite dikes in Scott County, Ark., by H. D. Miser and C. S. Ross. 10 pages, 1 plate, 2 text figures.

Describes an occurrence of peridotite on which considerable money has been spent in prospecting and making analyses in the hope of finding diamonds or other minerals of value, but without success. The authors conclude that even if diamonds occur here they could not be recovered economically.

BULLETIN 735-I. Diamond-bearing peridotite in Pike County, Ark., by H. D. Miser and C. S. Ross. 48 pages, 8 plates, 3 text figures.

Describes an area in southwestern Arkansas in which several thousand diamonds have been produced since 1906. The diamonds are found in peridotite, an igneous rock that occurs in several forms, both intrusive and effusive. The paper includes a comparison of the Arkansas area with the diamond fields of South Africa.

BULLETIN 735-J. The Los Burros district, Monterey County, Calif., by J. M. Hill. 26 pages.

Notes on a small district that has produced about \$90,000 worth of gold.

BULLETIN 736-B. Oil and gas prospects in and near the Crow Indian Reservation, Mont., by W. T. Thom, Jr. 19 pages, 1 plate.

Report on an examination made to determine the prospect of obtaining oil and gas in the Crow Reservation. Concludes that although the structure in the parts of the reservation that have not yet been drilled does not warrant enthusiasm, nevertheless the reservation affords a much better chance to the wildcatter than many other areas in Montana.

BULLETIN 736-C. Geology of the Wiles area, Ranger district, Tex., by C. E. Dobbin. 15 pages, 2 plates, 5 text figures.

Describes an area of 36 square miles in the southeastern part of Stephens County, Tex., with special reference to the geologic features that are related to the occurrence of oil and gas.

BULLETIN 736-D. The Osage oil field, Weston County, Wyo., by A. J. Collier. 42 pages, 5 plates, 1 text figure, 1 insert.

High-grade oil in commercial quantities was discovered in the fall of 1919 near the flag station of Osage, Wyo., and within a year a town of 1,500 persons had grown up and \$3,000,000 had been spent in developing the field. This report describes the field and concludes that although it will probably never be a great producer of oil, it will yield a moderate quantity for many years.

BULLETIN 736-E. Geology of the Ranger oil field, Tex., by Frank Reeves. 64 pages, 5 plates, 2 text figures.

Report on one of the most productive oil fields discovered in the United States during the last five years. Describes the geology of the region and the oil and gas development and gives recommendations for drilling.

LETIN 736-F. Possibility of finding oil in laccolithic domes south of the Little Rocky Mountains, Mont., by A. J. Collier and S. H. Cathcart. 8 pages, 2 text figures.

Describes the geology of a number of small areas where the rock beds have been arched upward into small domes that probably afford the most favorable conditions for the accumulation of oil within the general region where they occur.

LETIN 736-G. The Brooks, Steen, and Grand Saline salt domes, Smith and Van Zandt counties, Tex., by Sidney Powers and O. B. Hopkins. 65 pages, 4 plates, 2 text figures.

The known salt domes in the United States are confined to the Coastal Plain in Texas and Louisiana. This paper describes three domes in Texas and discusses the possibility of finding oil in them. Little is known of the nature of salt domes, and this paper is a contribution to their study.

LETIN 736-H. Stratigraphy of the El Dorado oil field, Ark., as determined by drill cuttings, by James Gilluly and K. C. Heald. 8 pages, 1 plate.

Report on a problem undertaken by the Geological Survey in order to facilitate development in the El Dorado field and furnish a guide to oil operators prospecting in surrounding territory.

LETIN 737. Manganese deposits of east Tennessee, by G. W. Stose and F. C. Schrader. 164 pages, 30 plates, 45 text figures.

Gives in detail the information obtained in a survey that was one of the projects undertaken in the country-wide investigation of sources of manganese during the World War. The work was done in cooperation with the Geological Survey of Tennessee. All the operating mines and nearly all the prospects and known deposits of manganese ore in the eastern part of the State were visited. Although the demand for manganese has decreased since the war, the facts here recorded form a useful addition to the inventory of the country's mineral wealth.

LETIN 738. The commercial granites of New England, by T. N. Dale. 504 pages, 34 plates, 96 text figures.

A revised and abridged combination of six bulletins by the same author on the granites of the several New England States, with considerable new information. The aim has been to present the subject in both its economic and its general scientific aspects and to make the scientific part intelligible to the general reader. The bulletin contains also statistics of production, a bibliography, and a glossary of technical terms.

LETIN 739-A. The Alaskan mining industry in 1921, by Alfred H. Brooks. 68 pages.

A summary showing that the mining industry was more prosperous in 1921 than in 1920, though owing to the low price of copper the value of the total mineral output showed a large decrease. The report gives statistics covering many years for most of the districts.

LETIN 739-B. Mineral deposits of the Wrangell district, southeastern Alaska, by A. F. Buddington. 25 pages, 1 plate, 4 text figures.

The only mineral deposits in the Wrangell district that have passed the prospecting stage yield gold and garnet, but numerous other minerals of possible economic value occur in the district. The deposits are described briefly in this report.

LETIN 739-C. Recent investigations of petroleum in Alaska: papers by S. R. Capps, F. H. Moffit, A. H. Brooks, and G. C. Martin. 69 pages, 2 plates, 4 text figures.

Contains papers on oil in the Cold Bay district of Alaska Peninsula and the Iniskin Bay district of Cook Inlet, a note on an oil seepage near Anchorage, and a paper on a supposed oil seepage in the Nenana coal field that is not derived from oil but is a tar distilled from burning coal beds.

LETIN 739-D. The occurrence of metalliferous deposits in the Yukon and Kuskokwim regions, Alaska, by J. B. Mertie, jr. 17 pages.

Presents in condensed form some generalizations and deductions regarding the distribution and occurrence of mineral deposits in interior Alaska, to serve primarily as a guide to the prospector.

LETIN 740. Mica deposits of the United States, by D. B. Sterrett. 354 pages, 29 plates, 96 text figures.

A compilation of the Geological Survey's available information on mica deposits in the United States. Gives a comprehensive review of the mica resources of the country and describes in detail many of the mines and prospects. Contains a short bibliography and sections on the geology and mineralogy of mica.

BULLETIN 741. The Jarbidge mining district, Nev., with a note on the Charleston district, by F. C. Schrader. 92 pages, 20 plates, 19 text figures.

Ore was discovered in the Jarbidge district in 1910, and the Geological Survey published a reconnaissance report on the district in 1912. The present report is supplemental to the earlier one and aims to bring it as nearly as possible up to date, containing much new material on the geology and ore deposits. The bulletin contains also a short description of the adjacent Charleston district.

BULLETIN 742. Chromite of Kenai Peninsula, Alaska, by A. C. Gill. 55 pages, 4 plates.

During the World War about 2,000 tons of chromite was mined at Claim Point, on Kenai Peninsula. This report describes the deposits at that place and at Red Mountain, 16 miles to the northeast.

BULLETIN 743. Geology of the Oatman gold district, Ariz., a preliminary report, by F. L. Ransome. 62 pages, 12 plates, 7 text figures.

The recent discovery of ore by diamond drilling in the Oatman district has led to renewed activity in prospecting and to a demand for information concerning the geology of the district. To meet this demand in some measure the present preliminary report has been prepared. The general features of the geology of the district and the occurrence of the ore deposits are set forth, and the author gives such practical conclusions as have so far been reached.

BULLETIN 745. The Kotsina-Kuskulana district, Alaska, by F. H. Moffit and J. B. Mertie, jr. 159 pages, 19 plates, 8 text figures.

The work of the Geological Survey in Alaska comprises, first, topographic and geologic reconnaissance surveys that determine the general distribution and geologic occurrence of mineral deposits, and, second, detailed investigations in areas where the deposits are of sufficient promise to justify the work. In areas of copper deposits it is particularly desirable to have full geologic information before installing the large plants that are necessary to mine and concentrate the ores. Reconnaissance surveys of the Kotsina-Chitina copper belt were completed about 20 years ago. The present report sets forth the results of a detailed examination of the area. It contains a complete analysis of the economic problems relating to the ore deposits and is a noteworthy contribution to knowledge of the geology.

BULLETIN 751-A. Continuity of some oil-bearing sands of Colorado and Wyoming, by W. T. Lee. 26 pages, 6 plates, 3 text figures.

Deals with the correlation of stratified rocks in the lower part of the Cretaceous system and its bearing on the discovery of oil and gas. Attempts to clarify the stratigraphic problems by showing the continuity of beds through areas where they have been known under different names.

WATER-SUPPLY PAPER 463. Surface water supply of the United States, 1917: Part XII, North Pacific drainage basins, B, Snake River basin; G. C. Baldwin, G. L. Parker, and F. F. Henshaw, district engineers. 168 pages, 2 plates.

One of the annual reports giving results of stream gaging.

WATER-SUPPLY PAPER 469. Surface waters of Wyoming and their utilization, by Robert Follansbee. 341 pages, 1 map.

Records of stream flow in Wyoming have been collected by the United States Geological Survey and the State engineer since 1894. These records have served as a basis for the development of irrigation and power and for the adjudication of water rights, and they are constantly becoming more valuable in connection with the utilization of the surface waters. The published records are scattered through Federal and State reports, many of which are out of print. Numerous other records given have never been published. This paper sets forth the essential facts regarding the surface-water supply and its use as a basis for investigation leading to the future development of the State's resources.

WATER-SUPPLY PAPER 473. Surface water supply of the United States, 1918. Part III, Ohio River basin; A. H. Horton and C. G. Paulsen, district engineers. 120 pages, 2 plates.

WATER-SUPPLY PAPER 478. Surface water supply of the United States, 1918. Part VIII, Western Gulf of Mexico basins; G. A. Gray and C. E. Ellsworth, district engineers. 106 pages, 2 plates.

WATER-SUPPLY PAPER 479. Surface water supply of the United States, 1918. Part IX, Colorado River basin; Robert Follansbee, C. C. Jacob, A. B. Fulton, and C. E. Ellsworth, district engineers. 194 pages, 2 plates.

WATER-SUPPLY PAPER 480. Surface water supply of the United States, 1918, Part X, The Great Basin; C. C. Jacob, A. B. Purton, H. D. McGlashan, F. F. Henshaw, G. C. Baldwin, and Robert Follansbee, district engineers. 277 pages, 2 plates.

WATER-SUPPLY PAPER 482. Surface water supply of the United States, 1918, Part XII, North Pacific slope drainage basins; A, Pacific basins in Washington and upper Columbia River basin; G. L. Parker and W. A. Lamb, district engineers. 178 pages, 2 plates.

WATER-SUPPLY PAPER 483. Surface water supply of the United States, 1918, Part XII, North Pacific slope drainage basins; B, Snake River basin; G. C. Baldwin, G. L. Parker, A. B. Purton, and F. F. Henshaw, district engineers. 176 pages, 2 plates.

WATER-SUPPLY PAPER 484. Surface water supply of the United States, 1918, Part XII, North Pacific slope drainage basins; C, Lower Columbia River basin and Pacific slope drainage basins in Oregon; F. F. Henshaw and G. L. Parker, district engineers. 140 pages, 2 plates.

Seven of the annual reports giving results of stream gaging.

WATER-SUPPLY PAPER 486. Water powers of the Cascade Range, Part IV; Wenatchee and Entiat basins, by G. L. Parker and Lasley Lee. 80 pages, 9 plates, 3 text figures.

The fourth of a series of reports prepared under a cooperative agreement with the Washington State Board of Geological Survey. Describes an area in the central part of the State, on the east slope of the Cascade Range, in Chelan County. Gives analyses and summaries that indicate the power resources of the area and show the relative value of chosen sections of the river systems. Outlines a scheme of power projects that will be consistent with the highest ultimate development in the region.

WATER-SUPPLY PAPER 488. The floods in central Texas in September, 1921, by C. E. Ellsworth. 60 pages, 8 plates, 5 text figures.

Report on a series of floods that caused the loss of at least 224 lives and damage to property amounting to more than \$10,000,000. Contains numerous diagrams and maps and gives a concise account of previous floods in this general area.

WATER-SUPPLY PAPER 490-C. Routes to desert watering places in the lower Gila region, Ariz., by C. P. Ross. 49 pages, 7 plates, 1 text figure.

WATER-SUPPLY PAPER 490-D. Routes to desert watering places in the Papago country, Ariz., by Kirk Bryan. 123 pages, 10 plates, 1 text figure.

The third and fourth in the series of "desert guides" for the southwestern region of the United States. Each contains three large relief maps showing roads and watering places, a general description of the region, suggestions for desert travel, detailed road logs, and an index of watering places.

WATER-SUPPLY PAPER 493. Hydroelectric power systems of California and their extensions into Oregon and Nevada, by F. H. Fowler. 1,326 pages, 73 plates, 50 text figures.

California was one of the first States to utilize hydroelectric energy, the first plant in the State having been put into operation more than 30 years ago. Since that time the installation of hydroelectric plants and the extension of long-distance transmission systems in California have kept well abreast of the best current practice in electrical engineering. The most important phases of this development have been described in numerous articles and technical works, but these are widely scattered, and the need of a comprehensive work on the existing developments has led to the compilation of the present volume. This book contains a vast amount of first-hand information on the history, markets, electric systems, finances, and rates of each of the operating hydroelectric companies in the State and shows the general conditions under which they have attained their present stage of development. It thus represents an economic as well as an engineering study.

WATER-SUPPLY PAPER 495. Geology and ground-water resources of Sacramento Valley, Calif., by Kirk Bryan. 297 pages, 19 plates, 10 text figures.

The Great Valley of California, of which Sacramento Valley forms the northern half, is comparable with the valleys of the Ganges and the Nile in fertility, climate, and character of drainage system but is much more sparsely populated. Its more intensive development depends primarily on water. Until recently the growing of wheat and barley by dry farming has been the chief agricultural industry, but immense land holdings are being

subdivided, irrigation systems are being constructed, and small farm units, intensive cultivation, and high-priced crops are transforming the agricultural life of the valley. This development involves the use of both surface water and ground water. The present paper sets forth the available information on the ground-water resources of the valley, gives notes on well and pumping problems, and discusses the several subdivisions of the valley in detail.

WATER-SUPPLY PAPER 496. The industrial utility of public water supplies in the United States, by W. D. Collins. 63 pages, 1 plate, 1 text figure.

The effects of mineral constituents on the value of water have a familiar illustration in the difficulty of using soap with water that is "hard." Such effects are troublesome in many industrial plants, such as commercial laundries, bleaching and dyeing works, and plants for the manufacture of soft drinks, food products, chemicals, and numerous other articles. Foaming, corrosion, and scale caused by the use of bad water in steam boilers necessitate large and continuous expenditures to prevent disaster. This paper gives analyses of water in public supplies at 287 places in the United States, each of which has a population of more than 25,000. These analyses were made by well-established methods and are undoubtedly accurate, and the samples were as representative as any that could be obtained. The paper also contains notes on the treatment of the water to improve its quality for industrial use.

WATER-SUPPLY PAPER 500. Contributions to the hydrology of the United States, 1921. 74 pages, 4 plates, 17 text figures.

Contains three papers on Coeur d'Alene Lake, Idaho, irrigation near Gage, Okla., and run-off in the Rocky Mountain region. These papers had been previously published separately.

WATER-SUPPLY PAPER 504. Surface water supply of the United States, 1919-20. Part IV, St. Lawrence River basin; W. G. Hoyt, C. C. Covert, and C. H. Pierce, district engineers. 192 pages, 2 plates.

WATER-SUPPLY PAPER 507. Surface water supply of the United States, 1919-20. Part VII, Lower Mississippi River basin; Robert Follansbee and R. C. Rice, district engineers. 52 pages, 2 plates.

WATER-SUPPLY PAPER 508. Surface water supply of the United States, 1919-20. Part VIII, Western Gulf of Mexico basins; C. E. Ellsworth, district engineer. 140 pages, 2 plates.

Three of the annual progress reports giving results of stream gaging.

MINERAL RESOURCES OF THE UNITED STATES, 1919; Part I, Metals. 964 pages, 5 plates, 10 text figures.

A consolidation of the chapters on the several metals issued separately at different dates between June, 1920, and January, 1922, with an introduction and general summary covering metals and nonmetals. The statistics reflect the reaction from intensive production for war purposes and the unsettled state of industry in general in 1919.

MINERAL RESOURCES OF THE UNITED STATES, 1919; Part II, Nonmetals. 569 pages, 23 text figures.

The annual statistical volume on nonmetallic mineral resources—a consolidation of chapters published separately at intervals between August, 1920, and April, 1922. Owing to the delay in obtaining some of the figures a few of the customary chapters are omitted, but the complete figures are to be given in later volumes.

MINERAL RESOURCES OF THE UNITED STATES, 1920. 6 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1921. 53 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1922. 4 advance chapters.

GEOLOGIC FOLIO 214. Raton-Brilliant-Koehler, N. Mex.-Colo., by W. T. Lee. 17 pages of folio text, 9 maps, 1 structure-section sheet, 1 sheet of coal sections, 12 plates, 21 text figures.

The three quadrangles described in this folio lie mainly in New Mexico. They constitute the central part of the coal-producing area known as the Raton Mesa region and are in the transitional zone between the typical Great Plains and the mountains. These quadrangles cover an area of 717 square miles, five-sixths of which lies within a single land grant and contains few roads or settlements. This folio describes the geography of the Great Plains province and treats the geology of the three quadrangles in detail. The principal economic resource of this area is coal, and the folio gives numerous graphic sections of coal beds and analyses to show the quality of the coal, which has a high heating value.

TOPOGRAPHIC AND OTHER MAPS as indicated below. (The maps marked * were also published with a green overprint showing woodland areas.)

Alaska.

Map of the Territory in four colors: Scale, 1 inch=39.5 miles. Size, 35½ by 51 inches.

New map on same scale as the Geological Survey's wall map of the United States, showing many special features, such as the boundaries of the judicial divisions (printed in red) and the Government railroad from Seward to Fairbanks, also parts of Yukon and British Columbia.

Arizona and Utah.

Plan and profile of Colorado River, Lees Ferry, Ariz., to mouth of Green River, Utah; San Juan River, mouth to Chinle Creek, Utah; and certain tributaries: Scale, 1 inch=¼ mile; contour interval on land 20 feet, on river surface 5 feet; vertical scale of profiles, 1 inch=20 feet. Size, 21 by 27 inches. 22 sheets (16 plans, 6 profiles).

These sheets give the results of special surveys and investigations in Utah and Arizona, made in cooperation with the Southern California Edison Co., to ascertain the feasibility of storage and diversion of the waters of Colorado River. The plan sheets show the topography of a belt of country along Colorado River for 216 miles and along San Juan River for 133 miles, and the profile sheets show the slope of the stream.

California.

Academy: Scale, 1 inch=½ mile; contour interval, 5 and 25 feet. Latitude, 36° 52' 30" to 37°; longitude, 119° 30' to 119° 37' 30".

Map of part of Fresno County, in the hilly zone between San Joaquin Valley and the foothills of the Sierra Nevada. The area contains little level land and is rather rugged in a small way. Its southwest corner lies in San Joaquin Valley at only 430 feet above sea level, but several hills in the northern part reach altitudes of 1,600 feet or more. The area is poorly watered and sparsely settled.

Biola: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 45' to 36° 52' 30"; longitude, 120° to 120° 7' 30".

Map of parts of Fresno and Madera counties, near the center of San Joaquin Valley. The area lies in an alluvial plain whose surface descends from 265 feet above sea level in the northeast corner to 210 feet in the southwest corner. San Joaquin River crosses its center in a sinuous trench one-eighth to one-fourth mile wide and 20 feet deep, lying within another trench half a mile wide and 25 feet deep. The area south of the river is irrigated by ditches, most of which follow low alluvial ridges built by distributaries of the river during floods.

Chaney Ranch: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 37' 30" to 36° 45'; longitude, 120° 30' to 120° 37' 30".

Map of part of Fresno County, on the southwest side of San Joaquin Valley. Nearly all the area is a flat alluvial slope, which descends from 450 feet above sea level at the base of the foothills in the southwest corner to 265 feet in the northeast corner. Little Panoche Creek, from which some of the southwestern part of the area is irrigated, flows northeastward on an alluvial ridge that it has built up.

Dos Palos: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 52' 30" to 37°; longitude, 120° 37' 30" to 120° 45".

Map of parts of Merced and Fresno counties, in the southwestern part of San Joaquin Valley. The southern two-thirds of the area is an alluvial apron 215 to 115 feet above sea level, merging into the flood plain of San Joaquin River at 105 to 115 feet in the northeastern part. The area contains no permanent streams but is crossed by two irrigation canals, from which ditches distribute water.

Frebaugh: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 45' to 36° 52' 30"; longitude, 120° 22' 30" to 120° 30".

Map of an area in Fresno and Madera counties, near the middle of San Joaquin Valley. The northeastern part is in the flood plain of San Joaquin

River, 140 to 160 feet above sea level, and is traversed by the meandering trench, 15 to 20 feet deep, of the river and by flood channels, some of which are occupied by irrigation canals. The southeastern part is a gentle alluvial slope that rises from 150 feet above sea level near the river to 255 feet in the southwest corner and is almost wholly unsettled.

Fresno: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $119^{\circ} 45'$ to $119^{\circ} 52' 30''$.

Map of part of Fresno County, in the eastern part of San Joaquin Valley, including in the northeast corner most of the city of Fresno. The surface has little relief and descends southwestward from 305 feet above sea level in the northeast corner to 245 feet in the southwest corner. Low alluvial ridges built by streams from the foothills traverse the northern half of the area. In the southern half a number of small ponds and playas are in shallow northwestward-trending depressions.

Friant: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 and 25 feet. Latitude, $36^{\circ} 52' 30''$ to 37° ; longitude, $119^{\circ} 37' 30''$ to $119^{\circ} 45'$.

Map of an area in Fresno and Madera counties, at the northeast margin of San Joaquin Valley. The southwestern part, 350 to 400 feet above sea level, is a broad alluvial apron at the base of the foothill country, which is rolling and rises in a few summits to 1,500 feet or more. San Joaquin River emerges from a canyon above Friant and flows in a flat-bottomed valley 150 feet below the general level of the alluvial apron.

Kearney Park: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $119^{\circ} 52' 30''$ to 120° .

Map of part of Fresno County, in San Joaquin Valley between San Joaquin and Kings rivers. The nearly flat valley plain slopes from 265 feet above sea level in the northeast corner to 210 feet in the southwest corner. There are no permanent streams, but much of the area is traversed by irrigation ditches, and there are a few intermittent ponds.

Kerman: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, 120° to $120^{\circ} 7' 30''$.

Map of part of Fresno County, in San Joaquin Valley, a few miles south of the river. The surface slopes southwestward away from San Joaquin River and toward Kings River, from 240 feet above sea level in the northeast corner to 180 feet in the southwest corner. There are no permanent streams, but a few intermittent ponds lie in shallow depressions.

Little Panoche: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $120^{\circ} 37' 30''$ to $120^{\circ} 45'$.

Map of part of Fresno County, in the southwestern part of San Joaquin Valley. The southwest corner lies on the slope of the Panoche Hills—foothills of the Diablo Range—at 1,000 feet above sea level. The general surface descends northeastward from about 650 feet at the base of the hills to 175 feet in the northeast corner. The area contains no permanent streams and is almost uninhabited.

Oil and gas fields of the State of California: Scale, 1 inch=8 miles.

The productive oil and gas fields, the main pipe lines, and the oil refineries are shown by distinctive colors and symbols.

Parks Bar: Scale 1 inch= $\frac{1}{2}$ mile; contour interval, 5 and 25 feet. Latitude, $39^{\circ} 7' 30''$ to $39^{\circ} 20'$; longitude, $121^{\circ} 7' 30''$ to $121^{\circ} 22' 30''$.

Map of an area in Yuba and Nevada counties, mainly in the valley of Yuba River, near the point where it emerges from the foothills of the Sierra Nevada. Above The Narrows the river flows in a winding V-shaped gorge, 700 feet deep, between hills that stand 1,100 to 1,400 feet above sea level. Below The Narrows the valley is 100 to 300 feet deep with steep walls.

***Pozo:** Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, $35^{\circ} 15'$ to $35^{\circ} 30'$; longitude, $120^{\circ} 15'$ to $120^{\circ} 30'$.

Map of part of San Luis Obispo County, in the heart of the Coast Ranges. The La Panza Range crosses the center of the area from northwest to southeast. Nearly the whole area is mountainous; the summits range from 1,700 feet above sea level in the northern part to 3,700 feet or more in the highest peaks of the La Panza Range. The main valleys are cut down to only 1,200 feet above sea level.

azo Farm: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 52' 30''$ to 37° ; longitude, $120^{\circ} 22' 30''$ to $120^{\circ} 30'$.

Map of an area in San Joaquin Valley in Madera and Fresno counties. The surface is extremely flat, the total difference of altitude being only 35 feet in the entire area of 60 square miles. San Joaquin River flows northwestward in a channel to which it is confined in some places by low levees, though in others it meanders slightly on a flood plain that is intersected by small channels and dotted with intermittent ponds.

Preston Peak: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, $41^{\circ} 30'$ to 42° ; longitude, $123^{\circ} 30'$ to 124° .

Map of parts of Del Norte and Siskiyou counties, in the Klamath Mountains, which occupy the entire area. Many summits reach altitudes of 5,000 to 6,500 feet, and Preston Peak, in the northeastern part, stands 7,310 feet above sea level. The valleys of the main streams are several thousand feet deep, and Klamath River crosses the extreme southwest corner at an elevation of less than 100 feet above sea level.

Round Mountain: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 and 25 feet, changing on the 550-foot contour. Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $119^{\circ} 30'$ to $119^{\circ} 37' 30''$.

Map of an area in Fresno County, on the northeast side of the San Joaquin Valley. The greater part is occupied by an upland, whose sloping surface is rather rough on a small scale, rising from 350 feet above sea level in the southwest corner to 500 feet in the northeast corner. Along the east side many small knobs and a few larger buttes rise 100 to 400 feet above the upland.

Sanger: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $119^{\circ} 30'$ to $119^{\circ} 37' 30''$.

Map of part of Fresno County, in the eastern part of San Joaquin Valley, whose general surface descends from 410 feet above sea level in the northeast corner to 315 feet in the southwest corner. It is crossed by low, irregular southwestward-trending alluvial ridges, built by flood distributaries of Kings River, which enters the eastern part in a great bend and flows in a shallow trench in a flood plain 2 miles wide, bounded by an irregularly cusped scarp 25 feet high.

Sawyers Bar: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 41° to $41^{\circ} 30'$; longitude, 120° to $120^{\circ} 30'$.

Map of parts of Siskiyou, Trinity, and Humboldt counties, in the Salmon Mountains, which occupy the entire area and reach altitudes of 7,000 to 8,000 feet above sea level. Thompson Peak, near the southeast corner, stands 8,936 feet above sea level. The main valleys are 4,000 feet or more deep, and Klamath River just enters the western margin at an altitude of only 500 feet above sea level.

Selad: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, $41^{\circ} 30'$ to 42° ; longitude, 123° to $123^{\circ} 30'$.

Map of part of Siskiyou County, in the Klamath Mountains, which occupy the entire area. Many summits reach altitudes of 6,000 to 7,500 feet, and Red Mountain, in the southeastern part, stands 8,317 feet above sea level. Klamath River flows in a tortuous gorge 2,000 to 4,000 feet deep. The Salmon Mountains, in the southern part, bear traces of former glaciation, especially a number of small lakes in cirques.

Tufts Ranch: Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet. Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $120^{\circ} 22' 30''$ to $120^{\circ} 30'$.

Map of an area in Fresno County, in the southwestern part of San Joaquin Valley. The whole area lies on a flat alluvial slope that descends from 340 feet above sea level in the southwest corner to 175 feet in the northeast corner.

Colorado.

Conejos: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 37° to $37^{\circ} 30'$; longitude, 106° to $106^{\circ} 30'$.

Map of parts of Conejos, Rio Grande, Alamosa, and Archuleta counties, mainly in the eastern foothills of the San Juan Mountains. The western part is a mountainous plateau that stands 11,000 to 12,000 feet above sea level and is trenced by the canyons of Conejos River and Alamosa Creek, which are cut down below 9,000 feet. East of the mountains the surface falls abruptly to San Luis Valley, 7,500 feet above sea level. Where the streams emerge into the valley they split into distributaries and are tapped by irrigation canals.

Paradox Valley: Scale, 1 inch=2 miles, contour interval, 100 feet. Latitude, 38° to 38° 30'; longitude, 108° 30' to 109°.

Map of parts of Montrose and San Miguel counties, mainly in the San Miguel Plateau. The general surface, which lies 5,700 to 7,000 feet above sea level, includes mesas whose flat summits are 7,000 feet or more above sea level; broad, shallow basins whose surface slopes gently from all sides toward the center; canoe-shaped valleys with steep walls facing inward; and ridges with steep slopes toward the valleys and gentle slopes toward the basins. Some peaks reach altitudes of 8,000 feet. The northeast corner lies on the Uncompahgre Plateau at altitudes of 8,800 to 9,800 feet. Dolores River crosses the area in a highly meandering course, flowing on a flood plain across the valleys and in a canyon 500 to 1,300 feet deep through the mesas and ridges.

State map: Scale, 1 inch=8 miles.

Base map of the State of Colorado in two colors. It shows county and township boundaries, location and names of all towns, most of even the smaller settlements, and the railroads (in black), also the rivers and many of the smaller streams and water features (in blue).

Connecticut.

[See Massachusetts, Rhode Island, and Connecticut.]

District of Columbia.

[See Maryland, Virginia, and the District of Columbia.]

Georgia.

Harlem: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 33° 15' to 33° 30'; longitude, 82° 15' to 82° 30'.

Map of an area in McDuffie, Columbia, Jefferson, Richmond, Warren, Glascock, and Burke counties, at the inner margin of the Coastal Plain and partly on the Piedmont Upland. The general upland surface descends from nearly 600 feet above sea level in the northwest corner to 400 feet in the southeast corner.

Illinois.

[See also Wisconsin and Illinois.]

* **Barrington:** Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° to 42° 15'; longitude, 88° to 88° 15'.

Map of parts of Cook, Lake, McHenry, and Kane counties, in the Lake Plains. The general altitude is between 700 and 900 feet above sea level. Nearly the whole area is occupied by a morainal belt of Wisconsin drift, consisting of an intricate assemblage of knolls and ridges, undrained hollows, and small formless valleys. Most of the surface is poorly drained, many of the hollows being occupied by small ponds or swamps, but Fox River crosses the northwest corner.

* **Carbondale:** Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 37° 30' to 37° 45'; longitude, 89° to 89° 15'.

Map of parts of Williamson, Union, Jackson, and Johnson counties. The northern part, which lies in the Prairie Plains, is a rolling plain 400 to 460 feet above sea level, cut by broad, shallow valleys 50 feet deep. The central and southern part, lying in the northern part of the Shawneetown Hills, is moderately hilly, the summits standing 600 to 860 feet above sea level. The streams in the southern part are unobstructed and are rapidly eating their way into the divide, but the larger streams in the northern part flow in crooked courses on the silt that fills their valleys.

* **Joliet:** Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 41° 30' to 41° 45'; longitude, 88° to 88° 15'.

Map of part of Will, Du Page, and Cook counties, in the northeastern part of the State. The general surface slopes gently from 790 feet above sea level in the northeast corner to 640 feet in the southwest corner and is crossed by several old glacial drainage channels 50 feet deep, with flat, somewhat marshy bottoms. Des Plaines River flows in the largest of these valleys, which is also traversed by the Chicago Drainage Canal, the Illinois and Michigan Canal, and several railroads. The eastern side of the area is occupied by hills left by the glaciers, and the western part is mainly a gently rolling plain.

Iowa.

Fort Dodge: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 30' to 42° 45'; longitude, 94° to 94° 15'.

Map of parts of Webster and Humboldt counties, in the north-central part of the State. The greater part is a rolling prairie country that lies about 1,150 feet above sea level and is traversed by a few shallow valleys, in many of which the streams have been confined to artificial channels. Des Moines River flows southward across the western part in a sinuous trench 100 feet deep and half a mile wide, bordered in part by bluffs and in part by slopes on which one or two faint terraces are developed.

Lehigh: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 15' to 42° 30'; longitude, 94° to 94° 15'.

Map of an area in Webster County, in the north-central part of the State. Most of the area lies on a rolling prairie upland that stands 1,080 to 1,180 feet above sea level. Des Moines River flows southeastward across the northern part in a meandering trench 150 feet deep, whose steep walls are furrowed by gullies. The tributaries descend to the river through similar steep-walled trenches, some of which extend back 2 or 3 miles. Much of the upland surface is so nearly level that the natural drainage is poor. This condition has been improved by ditching, which has produced the angular courses of many of the small streams.

Kansas.

State map: Scale, 1 inch=16 miles. Base map of Kansas, printed in black only. Similar to base map of Colorado. (See p. 18.)

Kentucky.

Electric generating stations and transmission lines used in public service in the State of Kentucky in 1921: Scale, 1 inch=8 miles.

The hydroelectric generating stations, the fuel-consuming generating stations, the stations combining these two sources of power, the substations, the switching stations, the distributing companies, and the primary transmission lines are shown by distinctive symbols, printed in red, on the United States Geological Survey's base map of Kentucky.

Oil and gas fields of the State of Kentucky: Scale, 1 inch=8 miles. Similar to map of California. (See p. 16.)

Maine.

Brassua Lake: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 45° 30' to 45° 45'; longitude, 69° 45' to 70°.

Map of parts of Somerset and Piscataquis counties, in the Moosehead Plateau, whose general surface stands 1,300 feet above sea level but is cut by valleys 100 to 200 feet deep. Misery Ridge, which crosses the southern part from northeast to southwest, reaches an altitude of 2,047 feet, and the summit of Squaw Mountain, in the southeast corner, 2,720 feet. Brassua Lake lies near the center, and a part of Moosehead Lake occupies the northeast corner. The two outlets of Moosehead Lake enter from the east and unite in Indian Pond, which drains southward through Kennebec River.

Lafayette National Park: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 44° 13' to 44° 30'; longitude, 68° 09' to 68° 28'.

Map of an area in Hancock County, comprising parts of the Mount Desert, Bar Harbor, and Swan Island quadrangles and including the whole of Mount Desert Island and a number of surrounding islands and a part of the neighboring mainland. Shows the position and outline of the new Lafayette National Park. The most conspicuous topographic feature is the mountain range of Mount Desert Island, several summits of which stand more than 1,000 feet above sea level and the highest (Mount Cadillac) reaches 1,532 feet. The range is crossed by deep gorges holding lakes and by the deep cleft of Somes Sound. On the back of the map is printed an outline description and explanation of the geology of the island.

- * Moosehead Lake: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 45° 30' to 45° 45'; longitude, 69° 30' to 69° 45'.

Map of an area in Piscataquis and Somerset counties, on the Moosehead Plateau, including the south-central part of Moosehead Lake. The lake, whose surface lies 1,028 feet above sea level, occupies a very irregular hollow in a rugged plateau that stands 1,150 feet above sea level. Above this plateau rise low mountains, the best known of which (Mount Kineo, 1,806 feet) forms a peninsula projecting into the lake from the eastern shore. The southwest corner lies on the northeastern slope of Squaw Mountain at an altitude of 2,700 feet. The lake is dotted with many islands, the largest of which are semimountainous, Sugar Island rising nearly 500 feet above the water surface.

State map: Scale 1 inch=16 miles.

Base map of Maine, printed in black. Similar to base map of Colorado. (See p. 18.)

Maryland and Virginia.

- Rockville (new edition): Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° to 39° 15'; longitude, 77° to 77° 15'.

Map of part of Montgomery and Howard counties, Md., and Fairfax County, Va., in the Piedmont Upland just north of Washington. The upland surface slopes southeastward from 720 feet above sea level in the northwest corner of the area to 340 feet in the southeast corner, and is cut by flaring valleys about 200 feet deep. A part of the gorge of Potomac River above Great Falls is shown in the southwest corner.

Maryland, Virginia, and the District of Columbia.

- Washington and vicinity (road map): Scale, 1 inch=4 miles. Latitude, 38° 30' to 39° 30'; longitude, 76° 3' to 77° 30'.

Shaded relief map of part of Maryland and Virginia, with the District of Columbia near the center of the area. Baltimore is near the northeast corner of the area, Annapolis on the eastern margin, and Frederick in the northwest corner. On the south the area extends just beyond Quantico, Va., and La Plata, Md. The main through roads and other improved roads are shown by red overprint, and the quality of the roads is indicated. On the back of the sheet is an interesting description of the country around Washington, in which the chief features of geographic, geologic, and historic interest are briefly considered.

Massachusetts, Rhode Island, and Connecticut.

- State map: Scale, 1 inch=16 miles.

Base map, printed in black. Similar to base map of Colorado. (See p. 18.)

Michigan.

- *Durand: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 45' to 43°; longitude, 83° 45' to 84°.

Map of an area in Genesee, Shiawassee, and Livingston counties, on the Thumb Upland. The general surface slopes from about 900 feet above sea level in the southeast corner to 750 feet in the northwest corner and is broken by irregular morainal ridges and hills, some of which stand 100 feet above the general surface. The Flint moraine crosses the northern part, and several less distinct and partly coalescent moraines cross the southern part. A number of swamps and ponds in the southeast corner occupy ice-block holes in the Portland moraine.

- *Flint: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 43° to 43° 15'; longitude, 83° 30' to 83° 45'.

Map of parts of Genesee, Tuscola, and Saginaw counties, on the northwestern slopes of the Thumb Upland, whose general surface slopes gently from 850 feet above sea level in the southeast corner to 650 feet in the northwest corner. There are several morainal belts made up of knolls 10 to 80 feet high, among which there are small undrained hollows containing ponds and bogs. Flint River and other streams flow in trenches 30 to 60 feet deep.

Holly: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 45' to 43°; longitude, 83° 30' to 83° 45'.

Map of parts of Genesee, Oakland, and Livingston counties, on the northwestern slope of the Thumb Upland, whose general surface slopes from 1,050 feet above sea level in the southeast corner to 800 feet in the northwest corner. The area is crossed by morainal belts, which include many knolls that stand 100 to 200 feet above the general level, interspersed with broad, flat areas and hollows, many of which are swampy or contain ponds.

Schoolcraft: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° to 42° 15'; longitude, 85° 30' to 85° 45'.

Map of parts of Kalamazoo and St. Joseph counties, near the western margin of the Thumb Upland, whose general surface there lies 850 to 900 feet above sea level. In the western part are several morainal belts consisting of groups of knolls 10 to 60 feet high, among which are small ponds and undrained hollows. The rest of the area is a poorly drained rolling plain. Numerous shallow depressions hold small lakes, some of which have no surface outlets.

Mississippi.

***Meridian:** Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 32° 15' to 32° 30'; longitude, 88° 30' to 88° 45'.

Map of part of Lauderdale County, in the Coastal Plain near the eastern boundary of the State. The general surface stands 500 to 550 feet above sea level and is cut by irregular valleys 100 feet deep with flat bottoms half a mile to a mile wide. In the southeastern part an irregular belt of low hills reaches altitudes of more than 600 feet. The upland is so much cut by ravines and small valleys that there is little level land except in the flat valley bottoms.

Missouri.

***Chillicothe:** Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° 45' to 40°; longitude, 93° 30' to 93° 45'.

Map of parts of Livingston and Grundy counties, near the southern margin of the Dissected Till Plains. The general upland surface lies 900 to 960 feet above sea level and is much cut by ravines and small valleys, which descend to the broad flat-bottomed valleys of Grand and Thompson rivers. The flood plains of these rivers lie 680 to 720 feet above sea level and contain numerous cut-off meanders and small oxbow lakes.

***Gallatin:** Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 30° 45' to 40°; longitude, 93° 45' to 94°.

Map of parts of Daviess, Caldwell, Livingston, and Grundy counties, in the southwestern part of the Prairie Plains. The generally rolling surface lies between 750 and 1,000 feet above sea level and is crossed by the broad alluvial valley of Grand River, a stream that meanders irregularly on a flood plain in which there are several oxbow lakes.

Nevada.

State map: Scale, 1 inch=8 miles.

Base map of Nevada, in one color (black). Similar to base map of Colorado. (See p. 18.)

New Hampshire and Vermont.

State map: Scale, 1 inch=16 miles.

Base map of New Hampshire and Vermont, printed in black. Similar to base map of Colorado. (See p. 18.)

New Mexico.

State map: Scale, 1 inch=8 miles.

Base map of New Mexico, in two colors. Similar to base map of Colorado. (See p. 18.)

Tyrone district: Scale, 1:24,000 or 1 inch=2,000 feet; contour interval, 25 feet.

Map of small area in Grant County lying between the Little Burro Mountains on the northeast and the Big Burro Mountains on the southwest. The Continental Divide crosses as a rather inconspicuous ridge from one mountain group to the other. The area is mainly hilly and ranges in altitude from 5,700 feet above sea level in the gulches to 8,000 feet at the summit of the Big Burro Mountains. The Tyrone mining district is situated in the northeastern part.

New York.

- * Childwold: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $44^{\circ} 15'$ to $44^{\circ} 30'$; longitude, $74^{\circ} 30'$ to $74^{\circ} 45'$.

Map of part of St. Lawrence and Franklin counties, in the northwestern Adirondacks. The general surface, which lies 1,600 feet above sea level, is cut by shallow valleys and interrupted by low, rocky hills. Mount Matumbia, in the southeast corner, stands 2,700 feet above sea level. The area has been heavily glaciated and is poorly drained, much of the surface being swampy and dotted with ponds.

- * Livingston Manor: Scale, 1 inch=1 mile; contour level, 20 feet. Latitude, $41^{\circ} 45'$ to 42° ; longitude, $74^{\circ} 45'$ to 75° .

Map of parts of Sullivan and Delaware counties, in the southern part of the Catskill Plateau, whose general surface stands 2,100 feet above sea level but is so much cut by deep valleys that it is scarcely recognizable. The northeastern part is occupied by the foothills of the Catskill Mountains, and the summit of Rattle Hill, near the northeast corner, is 2,600 feet above sea level. Ponds and small swamps occupy hollows in the upland surface, and there is little level land outside of narrow strips of flood plain in the main valleys, which are 500 feet or more deep and have generally steep sides.

- * Stark: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $41^{\circ} 15'$ to $44^{\circ} 30'$; longitude, $74^{\circ} 45'$ to 75° .

Map of part of St. Lawrence County, in the northwestern part of the Adirondack Plateau, whose general surface stands 1,500 to 1,600 feet above sea level in the southeast corner and descends to 1,100 feet in the northwest corner. Numerous small mountains rise a few hundred feet above the plateau, and the summit of Baldface Mountain reaches an altitude of 1,860 feet. There are few well-defined valleys, but the streams wander about between the hills, and much of the low ground is occupied by swamps and small ponds.

- * White Lake: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $41^{\circ} 30'$ to $41^{\circ} 45'$; longitude, $74^{\circ} 45'$ to 75° .

Map of part of Sullivan County, in the Allegheny Plateau, whose general surface lies 1,300 to 1,500 feet above sea level and is cut by valleys 300 to 500 feet deep. Delaware River crosses the extreme southwest corner in a trench 600 feet deep. The rather rough upland surface is well drained, and the hollows are occupied by numerous swamps and ponds.

New York and Pennsylvania.

- * Damascus: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $41^{\circ} 30'$ to $41^{\circ} 45'$; longitude, 75° to $75^{\circ} 15'$.

Map of parts of Wayne and Pike counties, Pa., and Sullivan County, N. Y., in the Pocono Plateau, whose general upland surface descends from 1,800 feet above sea level in the northwestern part to 1,200 feet in the southeastern part. Delaware River flows southward across the eastern part in a sinuous trench 400 to 600 feet deep. Small lakes and swamps occupy many of the hollows in the surface of the upland.

- * Long Eddy: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, $41^{\circ} 45'$ to 42° ; longitude, 75° to $75^{\circ} 15'$.

Map of parts of Delaware and Sullivan counties, N. Y., and Wayne County, Pa., in the Pocono Plateau, whose general upland surface stands 1,600 to 1,800 feet above sea level. The northern part is occupied by hills whose summits stand 2,200 to 2,300 feet above sea level and which are outliers of the Catskill Plateau. Delaware River flows southeastward in a meandering trench 800 to 1,000 feet deep, and the East Branch of the Delaware flows southwestward across the northwest corner in a similar but somewhat deeper trench.

North Dakota.

Garrison: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 47° 30' to 47° 45'; longitude, 101° 15' to 101° 30'.

Map of an area in McLean and Mercer counties, in the Missouri Plateau section of the Great Plains. The general surface of the plateau lies between 1,800 and 2,000 feet above sea level and is dissected by a few small valleys 100 to 200 feet deep. The northeastern part is occupied by a glacial moraine, in the hollows of which are many small ponds, most of them intermittent. Missouri River crosses the southwest corner in a sweeping curve, flowing in a valley 2 miles wide, with bluffs where the river flows close to the valley walls.

Ohio.

Shaded relief map of the State: Scale, 1 inch=6 miles. Size, 39½ by 43 inches.

The relief shading brings out well the general topographic character of the different parts of the State and the major differences in their topography. The larger physiographic divisions, especially the Allegheny Plateau and the Erie Plain, are easily distinguishable.

Oregon.

Elmira: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 44° to 44° 15'; longitude, 123° 15' to 123° 30'.

Preliminary map of a partly surveyed area in Lane County, at the southwestern margin of the Willamette Valley. Only the east side of the quadrangle, lying in the valley at 300 to 400 feet above sea level, has been surveyed. The most prominent features of the district are several buttes, of which the largest (Richardson Butte) stands 812 feet above sea level.

Monroe: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 44° 15' to 44° 30'; longitude, 123° 15' to 123° 30'.

Incomplete map of parts of Benton and Lane counties, on the west side of the Willamette Valley, whose nearly level surface here is 250 to 300 feet above sea level and is traversed by several abandoned channels of Long Tom River, some of them containing oxbow lakes.

Pennsylvania.

[See also New York and Pennsylvania.]

Altoona: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° 30' to 40° 45'; longitude, 78° 15' to 78° 30'.

Map of an area in Blair, Cambria, Clearfield, and Center counties, partly in the Allegheny Plateau and partly in the Appalachian Ranges, the two physiographic provinces being separated by the bold escarpment of the Allegheny Front, which crosses from southwest to northeast. The Allegheny Front is crowned by an irregular ridge—the Allegheny Mountains—whose chief summits stand 2,500 to 2,600 feet above sea level. Northwest of this ridge the upland surface ranges from 1,800 to 2,400 feet above sea level and is cut by valleys 500 to 1,000 feet deep. Southeast of the ridge the surface descends abruptly to a much dissected shelf, 1,700 to 1,800 feet above sea level, and then gradually to the valley of Little Juniata River, 900 to 1,000 feet above sea level. Southeast of this valley it rises again to 2,500 feet in the zigzag range of Brush Mountain, in the southeastern part. The city of Altoona is in the valley of Little Juniata River, which is also traversed by the main line of the Pennsylvania Railroad. The principal State highways across the quadrangle are distinguished by a red overprint.

Confluence: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° 45' to 40°; longitude, 79° 15' to 79° 30'.

Map of an area in Somerset and Fayette counties, near the eastern side of the Allegheny Plateau, which is much cut by valleys, some of them more than 1,000 feet deep, so that little of the original plateau surface remains. The area is crossed diagonally near its center by Laurel Hill, whose chief summits stand 500 feet above the plateau, and the highest point in the quadrangle, on Boardman Ridge, in the southeast corner, is 3,000 feet above sea level. At Confluence, in the southern part, Youghiogheny River is joined by Casselman River and Laurel Hill Creek.

- * Donegal: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° to 40° 15'; longitude, 79° 15' to 79° 30'.

Map of an area in Westmoreland, Fayette, and Somerset counties, near the east side of the Allegheny Plateau. The western part is crossed from north to south by Chestnut Ridge, whose chief summits stand 2,200 to 2,400 feet above sea level, and the southeast corner is crossed by Laurel Ridge, whose chief summits stand more than 2,900 feet above sea level.

- * Hanover: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° 45' to 40°; longitude, 78° 45' to 77°.

Map of parts of York and Adams counties, in the Piedmont Upland. The general upland surface of the southeastern half lies 700 to 800 feet above sea level, is cut by valleys 100 to 200 feet deep, and is traversed by interrupted ridges 100 feet higher. The central part is crossed by a valley 1 to 3 miles wide whose general surface lies 400 to 600 feet above sea level. Northwest of the valley are the Pigeon Hills, whose chief summit, 1,220 feet above sea level, is one of the highest points of the Piedmont Upland in Pennsylvania. The northwestern part lies in the rolling Gettysburg Plain, 500 to 600 feet above sea level. The Lincoln Highway crosses the northern part of the area, as shown by red overprint.

- * Lock Haven: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° to 41° 15'; longitude, 77° 15' to 77° 30'.

Map of parts of Clinton, Lycoming, and Center counties, mainly in the Appalachian Ranges. The northwest corner lies on the Allegheny Plateau, whose surface stands about 1,900 feet above sea level and is deeply cut by southeastward-descending ravines. Southeast of the plateau is Bald Eagle Valley, the northwestern part of which is occupied by a shelf, 2 to 3 miles wide, whose very irregular surface lies 1,000 to 1,200 feet above sea level. The southeastern part of the valley is the trench of Bald Eagle Creek and the West Branch of Susquehanna River and has a flat bottom a mile or so wide and 550 feet above sea level. The southern half is occupied by interlocking mountain ranges. Some of the valleys are broad and canoe-shaped; others are narrow and linear. The crests of the chief ranges stand 1,900 to 2,000 feet above sea level, and the highest point of Big Mountain reaches 2,300 feet.

- * New Florence: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° 15' to 40° 30'; longitude, 79° to 79° 15'.

Map of parts of Westmoreland, Indiana, Cambria, and Somerset counties, near the eastern margin of the Allegheny Plateau, whose general surface stands 1,400 to 1,600 feet above sea level and is crossed by Laurel Hill and Chestnut Ridge, which stand 1,000 to 1,200 feet above the plateau. Conemaugh River and Blacklick Creek flow westward in trenches 400 to 1,100 feet deep and cut through Chestnut Ridge in deep V-shaped gorges. The gorge of Conemaugh River is followed by the Pennsylvania Railroad between Johnstown and Blairsville intersection.

- * Philipsburg: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° 45' to 41°; longitude, 78° to 78° 15'.

Map of parts of Center and Clearfield counties, mainly in the eastern margin of the Allegheny Plateau, whose general surface is 1,700 to 2,100 feet above sea level and across which Moshannon Creek flows northeastward in a tortuous trench 200 to 500 feet deep. The plateau is bounded on the southeast by the ridge of the Allegheny Mountains, whose chief summits stand 2,200 to 2,400 feet above sea level. Southeast of the mountains the surface descends abruptly about 1,000 feet to Bald Eagle Valley, along which Bald Eagle Creek flows in a trench 100 feet deep and southeast of which the nearly straight ridge of Bald Eagle Mountain rises to 1,800 feet.

- * Pocono: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° to 41° 15'; longitude, 75° 15' to 75° 30'.

Map of parts of Monroe, Wayne, and Pike counties, in the Pocono Plateau. The northwestern half is on the plateau, whose surface lies generally 2,000 feet above sea level and is broken here and there by low swells and knobs but rises to 2,236 feet on Hardwood Ridge, at the northern margin. There are no deep valleys, and the depressions of the surface are nearly all occupied by swamps or ponds. The southeastern half is on the irregular escarpment by which the surface descends abruptly from the level of the plateau to less than 800 feet in the southeast corner. Two steam railroads climb the escarpment but follow devious courses to make the ascent. The terminal moraine of the Wisconsin drift crosses the southern

part; it is poorly developed where it ascends the escarpment but forms a ridge nearly 100 feet high across the plateau.

Williamsport: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° to 41° 15'; longitude, 77° to 77° 15'.

Map of parts of Lycoming, Union, Clinton, and Center counties, in the Appalachian Ranges. The West Branch of Susquehanna River crosses the northern part in a flat-bottomed valley a mile or so wide and 520 feet above sea level. Most of the area is occupied by zigzag mountain ranges, separated partly by broad, canoe-shaped valleys and partly by narrow, linear valleys. The crests of the main ranges stand 1,800 to 2,000 feet above sea level, and the crest of South White Deer Range reaches 2,140 feet in one place.

Rhode Island.

[See Massachusetts, Rhode Island, and Connecticut.]

Texas.

Altuda: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 30° 15' to 30° 30'; longitude, 103° 15' to 103° 30'.

Map of part of Brewster County, at the northeastern margin of the Mexican Highland. The Glass Mountains, whose chief summits stand 6,000 to 6,500 feet above sea level, occupy the central and eastern parts, and the Del Norte Mountains extend into the southwest corner. The rest of the area is occupied by broad slopes that descend from 4,700 feet above sea level at the foot of the mountains to 4,000 feet or less in the main valleys, which are drained by intermittent streams.

Armstrong: Scale, 1 inch=1 mile; contour interval, 5 feet. Latitude, 26° 45' to 27°; longitude, 97° 45' to 98°.

Map of parts of Kennedy, Brooks, and Hidalgo counties, in the Coastal Plain. The area is a nearly flat plain which descends very gently from 64 feet above sea level in the northwest corner to 15 feet above sea level near the southeast corner. Its surface is pitted by small, irregular depressions, 5 to 10 feet deep, many of which contain intermittent ponds. Knolls 15 to 25 feet high stand here and there, and in the eastern part are several areas of sand dunes. All the surface forms seem to be due to the work of the wind. The area contains no streams.

Arnhart: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 31° to 31° 15'; longitude, 101° to 101° 15'.

Map of an area in Irion and Crockett counties, on the northeastern margin of the Edwards Plateau. The southwestern part lies on the plateau at an altitude of 2,600 to 2,700 feet, and several outliers stand at the same altitude in the northern part. The remainder is occupied by the broadly flaring, nearly flat-bottomed valleys, 200 to 300 feet deep, of several intermittent streams that flow to the Middle Fork of Concho River.

Big Lake: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 31° to 31° 15'; longitude, 101° 15' to 101° 30'.

Map of parts of Reagan, Crockett, and Irion counties, in the Edwards Plateau, on the divide between Colorado River and the Rio Grande. The general surface of the plateau stands a little more than 2,700 feet above sea level and is cut by broad, shallow valleys 100 to 200 feet deep. The main divide, which is on the flattest part of the plateau, is in places poorly defined. Big Lake, a shallow temporary lake near the west side, has no outlet.

Fort Stockton: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 30° 45' to 31°; longitude, 102° 45' to 103°.

Map of part of Pecos County, nearly on the divide between Pecos River and the Rio Grande. The general surface is a rolling plain, descending from 3,300 feet above sea level in the southwest corner to 2,700 feet in the northeast corner. Several small mesas with precipitous sides stand 150 to 200 feet above the plain, and the summit of Twelvemile Mesa, in the southwest corner, is 3,722 feet above sea level.

Hess Canyon: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 30° 15' to 30° 30'; longitude, 103° to 103° 15'.

Map of part of Brewster and Pecos counties, in the trans-Pecos country. The northern half is occupied by the Glass Mountains, whose chief summits stand 5,800 feet or more above sea level. The southern half is occupied mainly by a sloping plain, whose surface descends from about 4,500 feet

above sea level at the base of the mountains to 4,150 feet near the margin of the area. In the southeastern part several irregular ridges stand 200 to 500 feet above the plain.

State of Texas. Scale, 1 inch=8 miles.

Base map of Texas, in four sheets, printed in two colors. Similar to base map of Colorado. (See p. 18.)

United States.

Oil and gas field of the United States: Scale, 1 inch=40 miles.

A revised edition of the map showing the oil and gas fields of the United States. The map shows by distinctive colors and symbols the oil and gas fields, the areas that have produced some oil and gas, the trunk pipe lines, and the refineries.

Utah.

[See also Arizona and Utah.]

Profile map of Weber River above Coalville and of East Canyon Creek from mouth to Taylor Creek, Utah. Six sheets.

Profile map of Provo River from Utah County line to Charleston and above Heber; North Fork of Provo River; Diamond Creek above Spanish Fork; American Fork; and Hobbie, Sixth Water, Payson, Santaquin, and Salt creeks, Utah. Ten sheets.

Profile map of Cottonwood, Little Cottonwood, and Mill creeks, tributary to Jordan River, Utah. Four sheets.

State map: Scale, 1 inch=8 miles.

Base map of the State of Utah in one color (black). Similar to base map of Colorado. (See p. 18.)

Vermont.

[See New Hampshire and Vermont.]

Virginia.

[See also Maryland and Virginia; Maryland, Virginia, and the District of Columbia; West Virginia and Virginia.]

*Chatham: Scale 1 inch=1 mile; contour interval, 20 feet. Latitude, $36^{\circ} 45'$ to 37° ; longitude, $79^{\circ} 15'$ to $79^{\circ} 30'$.

Map of part of Pittsylvania County, in the Piedmont Upland, whose general surface is 600 to 800 feet above sea level and is crossed by several northeastward-trending ridges that stand 200 to 400 feet higher. The surface is intricately cut by ravines and small valleys, some of which are 200 to 300 feet deep. The area is crossed from north to south by the main line of the Southern Railway.

Washington.

*Colockum Pass: Scale, 1 inch=2 miles; contour interval, 50 feet. Latitude, 47° to $47^{\circ} 15'$; longitude, 120° to $120^{\circ} 30'$.

Map of parts of Kittitas, Grant, and Douglas counties, mainly in the Wenatchee Mountains, whose south end occupies most of the area. The chief summits stand 3,800 to 6,350 feet above sea level. At the eastern base of the mountains is a sloping bench, 1,500 to 2,000 feet above sea level, across which Columbia River flows southward in a trench 1,000 feet deep and 1 to 2 miles wide. In the southwestern part the surface falls abruptly to Kittitas Valley, a broad basin lying 1,700 to 2,500 feet above sea level.

*Lake Crescent: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 48° to $48^{\circ} 15'$; longitude, $123^{\circ} 45'$ to 124° .

Map of an area in Clallam County, on the south shore of Juan de Fuca Strait, at the north base of the Olympic Mountains, whose foothills cross the southern part in several eastward-trending ranges and reach altitudes of 4,500 to 5,000 feet. Lake Crescent lies between two of these ranges.

* **Pysht:** Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 48° to 48° 15'; longitude, 124° to 124° 15'.

Map of a part of Clallam County, situated between the northern base of the Olympic Mountains and the Strait of Juan de Fuca. The southern half is occupied by several eastward-trending mountain ranges, some peaks of which reach altitudes of 3,500 feet or more above sea level. Soleduck River flows westward between two of the ranges, meandering on a flood plain a mile or more in width. North of the mountains, bordering the strait, it is a hilly country that lies less than 1,100 feet above sea level, down to which the valleys of Pysht and Clallam rivers have been cut.

† **Utan:** Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 47° 30' to 48°; longitude, 121° 30' to 122°.

Map of an area in King and Snohomish counties, at the western base of the Cascade Range. The eastern half, which is in the foothills of the Cascade Range, is rough, and many summits within it stand more than 5,000 feet above sea level. Preacher Mountain, in the extreme southeast corner, attains an altitude of 5,930 feet. Several streams flow westward from the mountains in gorges 3,000 feet or more in depth. A striking feature of the mountainous tract is the number of small lakes, some of them more than 4,000 feet above sea level, in ancient glacial cirques, most of which are at the heads of hanging valleys. The western half of the area, which lies in the Puget trough, consists chiefly of two sets of mesas, one set lying 400 to 600 feet and the other set 1,000 to 1,200 feet above sea level. The individual mesas are separated by valleys, some of them a mile wide and flat-floored, lying mainly less than 200 feet above sea level, and are broken in places by bold hills, some of which rise more than 2,000 feet above sea level. Evidences of glaciation are abundant, and the drainage of the western part, in particular, has been developed largely on a glaciated surface.

West Virginia.

† **Electric generating stations and transmission lines used in public service in the State of West Virginia in 1921.** Scale, 1 inch=8 miles. Similar to map of Kentucky. (See p. 19.)

† **Oil and gas fields of the State of West Virginia:** Scale, 1 inch=8 miles. Similar to map of California. (See p. 16.)

† **Waiteville:** Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 37° 15' to 37° 30'; longitude, 80° 15' to 80° 30'. (Only the part of the area that lies in West Virginia is shown.)

Map of an area in Monroe County, in the southeastern part of the State, among the Appalachian Ranges. Potts Mountain, along whose crest runs the State boundary, stands 2,900 to 3,900 feet above sea level, and Peters Mountain, in the northwest corner, reaches 4,045 feet in one summit. Between the two ranges the valley of Potts Creek, in which Waiteville is situated, lies between 1,900 and 2,100 feet above sea level.

West Virginia and Virginia.

† **Wardensville:** Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 39° to 39° 15'; longitude, 78° 30' to 78° 45'.

Map of an area in Hampshire and Hardy counties, W. Va., and Frederick and Shenandoah counties, Va., among the Appalachian ranges, several of which cross the area. The crests of the nearly even-topped ranges stand 2,000 to 2,900 feet above sea level, and the summit of Paddy Mountain, in the southeast corner, reaches 3,025 feet. The main valleys are cut down to less than 1,000 feet above sea level, and parts of the valleys of North River and Lost or Cacapon River have flat floors half a mile to a mile wide. At a point about 3 miles above Wardensville, Lost River, in crossing from one valley to another, flows underground for nearly 2 miles.

Wisconsin.

* **Blue Mounds:** Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° to 43° 15'; longitude, 89° 45' to 90°.

Map of parts of Iowa, Dane, and Sauk counties, in the Driftless Area. The area mapped is mainly an upland lying 1,100 to 1,200 feet above sea level and much cut by small valleys 100 feet deep. The Blue Mounds,

in the southeastern part, stand conspicuously above the upland, the western mound reaching an altitude of 1,716 feet. The upland is broken in the northern part by the valley, 3 miles wide, of Wisconsin River. Part of this valley is swampy, and the remainder is occupied by outwash terraces and sand dunes.

- * New Glarus: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 42° 45' to 43°; longitude, 89° 30' to 89° 45'.

Map of an area in Dane and Green counties, most of it in the Driftless Area. The upland surface lies 1,100 to 1,200 feet above sea level and is cut by broadly flaring valleys 100 to 250 feet deep. The terminal moraine of the Wisconsin drift crosses the northeast corner, through Verona, and the eastern edge is occupied by the western marginal fringe of the Illinoian drift. The valleys of the main streams, which flow southeastward, are partly blocked by outwash of Illinoian drift, and the streams wander about on marshy plains half a mile to 2 miles in width.

Wisconsin and Illinois.

- * Monroe: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 42° 30' to 42° 45'; longitude, 89° 30' to 89° 45'.

Map of an area lying chiefly in Green County, Wis., but just extending into Stephenson County, Ill. The quadrangle is situated in an upland, whose surface lies 1,000 to 1,100 feet above sea level and is cut by many ravines and valleys, those of the principal streams being 200 feet deep. Most of the quadrangle is covered with a thin sheet of glacial drift, but the northwestern part lies in the Driftless Area.

GEOLOGIC BRANCH.

SCOPE AND ORGANIZATION OF WORK.

The field covered by the research activities of the geologic branch is practically coextensive with the field covered by the science of geology. The work of this branch and that of the State geological surveys, the geologic faculties of the universities, some of the great endowed research institutions, and a relatively few individuals of exceptional enthusiasm and initiative together constitute the contributions that are being made to-day toward the development of this phase of natural science in the United States. In general, a spirit of cooperation pervades these groups of investigators, so that the work of each supplements that of the others. By coordinating activities, combining facilities, funds, and personnel, and exchanging information and experience through cooperation, the sum total of progress made is greatly increased.

In performing its part in this common work the geologic branch makes investigations in many of the departments of geology, although in none of them can it begin to fill the field, nor can it undertake independently or even aid many types of research that should be pursued. In others its participation is most meager because of the limitations in funds and personnel which it shares with many other research institutions. Nevertheless, many phases of geology, including paleontology, glaciology, mineralogy, petrography, physiography, mineral chemistry, and physics, and combinations of these utilized in economic studies are represented in its activities and in its staff specialists, and the results of the work appear in its publications.

The work of the branch on mineral resources combines statistical inquiry with a certain amount of direct study of the geologic environment of the products studied, so that production and development can be interpreted in terms of geology and in the light which geologic

studies throw on the magnitude of known sources of these products, and the possibilities of new sources and reserves. Mere statistics of production without this vivifying geologic interpretation made possible by the union of geologists and statisticians are relatively barren. It is a matter of regret that funds and personnel are not sufficient to carry this principle throughout the work on mineral resources.

The work of the division of chemistry and physics is, in a general sense, supplementary to that of the division of geology, in that its researches are directed to the chemical and physical aspects of geologic problems.

The organization of the branch has been a natural growth, adapted and fitted to the functions performed, and has not been materially changed for years. The three major subdivisions represent the most distinct fields into which these functions fall—geology, chemistry and physics, and mineral resources, each represented by an organization unit called a division.

The general organization throughout the fiscal year has been as follows:

Geologic branch:

David White, chief geologist until November 15, 1922.

W. C. Mendenhall, chief geologist from November 16, 1922, to June 30, 1923.

Division of geology: Sidney Paige, geologist, acting in charge.

Division of chemistry and physics: George Steiger, chief chemist, acting in charge.

Division of mineral resources: G. F. Loughlin, geologist in charge.

BRANCH FUNDS.

The act making appropriations for the Department of the Interior for the fiscal year ending June 30, 1923, carried the following items, from which the work of the geologic branch is supported:

Geologic surveys.....	\$300, 000
Scientific assistants (geologists, paleontologists, and chemist).....	20, 700
Mineral resources.....	125, 000
Chemical and physical researches.....	40, 000

In addition, geologic field work necessary in the classification of mineral lands was done by the aid of the appropriation made to the Survey for land classification, at a total cost of \$33,650. This is a decrease of \$52,000 in the amount available for geologic surveys and of \$5,100 in the amount available for land-classification work by comparison with the preceding fiscal year.

The special geologic and economic training represented in the branch personnel continue to be made available to other organizations, State and Federal, through cooperation, usually by assignment of members of the branch staff to the special problems involved, either wholly at the expense of the organization that requires the work done or on a cost-sharing basis. The Department of Justice, the Office of Indian Affairs, the Forest Service, the Reclamation Service, the Coal Commission, and a number of States thus received the benefit of the specialized training available in the branch. The cost to the cooperating organizations, in the form of salaries assumed or field expenses borne, was about \$15,000 for the fiscal year.

The gross total of funds available to the branch for the fiscal year, including direct appropriations, funds for land classification, and cooperative funds, was thus \$534,350.

DIVISION OF GEOLOGY.

ORGANIZATION AND PERSONNEL.

The division of geology as at present organized includes the 10 sections indicated below. It also exercises technical supervision over the section of geologic-map editing, a part of the publication branch.

Geology of metalliferous deposits: F. L. Ransome, geologist in charge.
 Paleontology and stratigraphy: T. W. Stanton, geologist in charge.
 Glacial geology: W. C. Alden, geologist in charge.
 Geology of iron and steel metals: E. F. Burchard, geologist in charge.
 Coastal Plain investigations: L. W. Stephenson, geologist in charge.
 Areal geology: Sidney Paige, geologist in charge.
 Geology of nonmetalliferous deposits: G. R. Mansfield, geologist in charge.
 Petrology: E. S. Larsen, jr., geologist in charge.
 Geology of oil and gas fields: K. C. Heald, geologist in charge.
 Geology of coal fields: M. R. Campbell, geologist in charge until January 31, 1923; W. T. Thom, jr., geologist in charge from February 1 to June 30, 1923.

In addition to the administrative organization, the division includes two important advisory committees—the committee on geologic names, T. W. Stanton, chairman, and the physiographic committee, M. R. Campbell, chairman. These committees consider in detail all problems falling within their respective fields and advise the chief geologist of their findings as a basis for administrative action.

At the beginning of the fiscal year the staff of the division included 123 geologists of various grades. During the year there were two resignations, one death, and four additions to the staff, so that the number of employees of this group at the end of the year was 124. Five draftsmen and seven preparators of fossils and skilled laborers were also attached to the division. In the clerical force there were three separations and one accession during the year, and the number employed at the end of the year was 30.

The most important change in personnel within the division during the year was the relief of M. R. Campbell, at his own request, of administrative responsibility for the section of coal-field geology, after 16 years of most efficient and productive service. Mr. Campbell will now be able to devote more energy to personal research and especially to physiographic work.

DIVISION FUNDS.

The total funds available for the work of the division for the fiscal year were as follows:

Geologic surveys-----	\$300, 000
Repayments (on account of work done for other Government establishments or other Geological Survey units).....	8, 674
Classification of lands-----	33, 650
Scientific assistants-----	17, 700
Search for potash deposits (from appropriation for chemical and physical researches)-----	5, 342
	<hr/>
	365, 366

The expenditure of these funds may be classified by subjects approximately as follows:

Economic geology of metalliferous deposits.....	\$55, 608
Economic geology of nonmetalliferous deposits.....	12, 902
Economic geology of fuels (oil, gas, coal).....	83, 067
Scientific researches not directly connected with economic geology (paleontology, glaciation, Coastal Plain formations, etc.).....	106, 168
Supervision, administration, salaries of clerical, technical, and skilled-labor forces, purchase and repair of instruments, office supplies, etc.....	107, 621
	<hr/> 365, 366

Of the amounts available for geologic work, approximately \$5,000 was used directly for field expenses, including the search for potash. About 88 per cent of this amount was expended west of the one hundredth meridian, and about 12 per cent east of it.

COOPERATION.

Cooperation with States and Federal agencies in the solution of problems involving geology has been continued. Examples of cooperative work of this character during the year are the preparation of a geologic map of Arizona, in cooperation with the Arizona Bureau of Mines and Geology; examinations of the Deep River coal field of North Carolina, the Brushy Mountain coal field of Virginia, the Iron Mountain iron ores of western Tennessee, and the Cretaceous formations of Alabama, in cooperation with the geological surveys of those States; a study of the geology and ore deposits of the Pend Oreille region and of reported platinum deposits in Idaho, in cooperation with the Idaho Bureau of Mines and Geology; examinations of dam and reservoir sites along the lower Colorado River and in Idaho, Oregon, and New Mexico, for the Reclamation Service, and of certain lands proposed for purchase under the Appalachian forest reserve act of the Forest Service.

The determinations of fossils sent in from various parts of the United States, the West Indies, and Central and South America and of the position of the rocks from which they came, by the paleontologists of the Survey, is a cooperative service of great usefulness especially appreciated by the State geological surveys and by the oil industry.

GENERAL REVIEW OF THE YEAR.

Few permanent changes in the technical force have been made during the year. The universities, many of which have adjusted their operations to the altered economic situation in the United States by increased budgets, promise to displace the mining industries as a chief source of losses from the trained staff of the Survey.

Many projects that were interrupted by the war have since been brought to completion, but the completion of others has been made difficult by loss of personnel. Emphasis, however, continues to be laid on the completion of projects already begun, though with many demands for new and important studies of great prospective value to science and to the mining industry, and with reduced funds

and reduced personnel, the progress made in completing work on hand is discouragingly slow.

Among the papers published during the year that represent researches of interest to the mining world are the following:

Silver enrichment in the San Juan Mountains, Colo. (Bull. 735-D).

Copper deposits of the Tyrone district, N. Mex. (Prof. Paper 122).

Geology and ore deposits of Shoshone County, Idaho (Bull. 732).

Geology of the Oatman district, Ariz. (Bull. 743).

Nitrate deposits in the Amargosa region, Calif. (Bull. 724).

High-grade clays of the eastern United States (Bull. 708).

Potash in the greensands of New Jersey (Bull. 727).

Manganese deposits of east Tennessee (Bull. 737).

Manganese deposits of the Batesville district, Ark. (Bull. 734).

Mica deposits of the United States (Bull. 740).

Oil shale of the Rocky Mountain region (Bull. 729).

A series of important papers on oil fields and on problems connected with oil development was also issued. Worthy of mention among these is the brief paper on the continuity of some oil-bearing sands of Colorado and Wyoming (Bull. 751-A), which has been well received by geologists engaged in oil development. Another of the geologic guidebooks that have proved so valuable to teachers and travelers was published, covering the Denver & Rio Grande Western route (Bull. 707), and several paleontologic and stratigraphic papers that represent definite advances in our knowledge of earth history and development were issued. Numerous reports, both economic and noneconomic, are awaiting publication.

Work in most of the fields of geology is of necessity carried on less extensively than before the war, owing to decreased funds, depleted staff, and increased field costs, yet systematic work is continued and researches that promise significant results are under way. Distinct progress has been made by C. Whitman Cross and his associates in the study of the San Juan Mountain region in southern Colorado. This area is geologically unique and has had a long and complex volcanic and physiographic history whose main events are now well understood. The research has been complicated and has often been interrupted, but the results will probably form as valuable a single contribution to the understanding of geologic processes as the Survey has yet made.

Another important research long under way, whose results were delivered in manuscript form toward the end of the fiscal year, is the study of the geology, geography, and mineral resources of southeastern Idaho by G. R. Mansfield. The complex structure and stratigraphy of this region have been satisfactorily worked out, and the report will no doubt be of great interest to students of tectonics and of geologic history. This region contains some of the most valuable rock phosphate beds of the West, so that the work done is of economic value also.

A continuing project of promise is the detailed study of the San Andreas rift in southern California being made by L. F. Noble as the Survey's part of a series of cooperative earthquake studies under the auspices of the Seismological Society of America. The Carnegie Institution and the Coast and Geodetic Survey are each carrying on coordinated parts of this work.

Special studies of the physical and chemical properties of sediments and of the fundamental principles of sedimentation have been

continued by T. W. Vaughan and a group of associates within and without the Survey.

The Survey's oil work has been active throughout the year, and a number of reports have been published and others submitted for publication. Numerous general studies that should be made for the benefit of the oil industry can not be undertaken for lack of funds and men, but researches are under way on the materials that constitute the source of petroleum and on the manner in which it was formed from these sources, on the porosity and texture of the reservoir rocks, on microscopic faunas as an aid in identifying and correlating beds, and on the cap-rock material of salt domes. The preparation of oil and gas field maps and of State geologic maps continues, as well as the usual areal and structural geologic mapping of selected districts.

Detailed studies of coal fields for the classification of coal lands and for the administration of the leasing act, as well as to guide future development, were resumed toward the end of the year on a somewhat larger scale than in recent years.

WORK OF THE DIVISION BY STATES.

ALABAMA.

Field work.—Charles Butts visited the Bessemer, Vandiver, Montevallo, and Columbiana quadrangles, Ala., to collect additional information for the revision of the geologic folios on these quadrangles, and to review the question of the identification of the Straven coal beds at the request of the State geologist. Field studies to establish the boundaries of the Cretaceous formations in connection with the preparation of a geologic map of Alabama were made by L. W. Stephenson and C. W. Cooke. E. F. Burchard examined the brown iron ores of the Russellville district.

Office work.—The Bessemer-Vandiver and Columbiana-Montevallo folios were revised by Charles Butts, who also prepared a description of the geology of the Alabama coal fields to be incorporated in a bulletin of the Bureau of Mines, containing analyses of coal from Alabama. C. W. Cooke continued work on his report on the upper Eocene and Oligocene formations of southern Alabama and western Florida, transmitted a paper on the correlation of the Vicksburg group for publication in "Shorter contributions to general geology," and prepared a geologic section for use in making a model of part of Alabama.

ARIZONA.

Field work.—F. L. Ransome, assisted by H. A. C. Jenison, finished field work in the Oatman gold district, Ariz. C. P. Ross completed field studies on the geology and ore deposits of the Christmas quadrangle and the Aravaipa and Stanley mining districts. Waldemar Lindgren under special agreement investigated mining districts in Yavapai County. N. H. Darton completed geologic studies in connection with the preparation of a geologic map of Arizona, in co-operation with the Arizona Bureau of Mines. H. E. Gregory and L. F. Noble made some reconnaissance stratigraphic investigations on the north side of the Grand Canyon, in the region of the Kanab and Kaibab plateaus. F. L. Ransome studied geologic problems of the Boulder Canyon and Black Canyon dam sites for the Reclamation Service, and H. A. C. Jenison examined the possible economic resources of the reservoir sites involved in proposed reclamation projects.

Office work.—F. L. Ransome completed and transmitted a preliminary report on the Oatman district, continued the preparation of the detailed report on the geology and ore deposits of that district, and revised the Ray geologic folio. He also completed a report for the Reclamation Service on the Boulder Canyon and Black Canyon dam sites and presented before the National Academy of Sciences an illustrated account of ancient high-level potholes along Colorado River. The geologic map of Arizona, with descriptive text, was completed

by N. H. Darton and transmitted to the Arizona Bureau of Mines. C. P. prepared and submitted for publication reports on the ore deposits in the vicinity of Christmas (Saddle Mountain and Banner mining districts) and on Stanley and Aravaipa districts and revised his report on the lower Gila region. E. S. Bastin, under contract, completed and submitted for publication a report on the origin of certain rich silver ores near Chloride and Kingman. Report on proposed dam sites on Colorado and San Juan rivers were prepared by H. D. Miser. A geologic description to accompany the Grand Canyon National Park folder was prepared by L. F. Noble for the National Park Service. G. Girty, Edwin Kirk, and T. W. Stanton studied and reported on Carboniferous Cambrian, Devonian, and Mesozoic fossils.

Publications.—Issued: Bulletins 735-E, 743; Professional Papers 131-B, 133. In press: Geologic Folio 217 (Ray).

ARKANSAS.

Office work.—A report on the stratigraphy of the El Dorado oil field, Arkansas, by James Gilluly and K. C. Heald, was completed and submitted for publication. Maps, illustrations, and descriptive text covering the DeQueen and Caddo quadrangles were revised and put in shape for publication as a professional paper by H. D. Miser, who also prepared a summary of the manganese reserves of the State in connection with a report on the manganese reserves of the United States.

Publications.—Issued: Bulletins 784, 796-H, 795-H, 795-I; press notice on geology of the El Dorado oil field.

CALIFORNIA.

Field work.—J. M. Hill made some field studies of the silver deposits in Randsburg, Calif., and did some reconnaissance work in several mining camps in the copper belt of Plumas County. W. S. W. Kew continued his work on the geology of the oil fields of southern Los Angeles County, nearly completing the mapping of the Fernando quadrangle. F. E. Matthes continued field work in the upper San Joaquin basin in connection with a report on the physiographic and glacial history of the basin. He also spent some time in reconnaissance work on the physiography of the foothills of the Sierra Nevada. L. F. Noble devoted several weeks to field work on the San Andreas rift.

Office work.—L. F. Noble continued the preparation of a report on nitrate in the Mohave Desert, the valley of Colorado River, and adjacent regions. He spent several days on office work relating to the San Andreas rift. J. M. Hill completed a reconnaissance report on the gold deposits of the Los Buena Vista district, Monterey County, and did some work on a report on the Rand silver district. Work was continued by F. E. Matthes on a report on the origin of the Yosemite Valley. He also prepared a paper on hanging valleys of the Yosemite region and has in progress a report on the physiography of the upper San Joaquin basin. J. S. Diller revised his report on the Lassen volcanic National Park. W. H. Dall and Edwin Kirk prepared reports on field material from the State. G. R. Mansfield prepared a press report on nitrate in southeastern California. W. S. W. Kew continued the preparation of a report on the upper Santa Clara River (Soledad Canyon) district, on the fault in southern California, and on the San Pedro Hills, Los Angeles County, the compilation of a geologic map of southern California. He revised a report on the oil and gas resources of the Los Angeles-Ventura district. He prepared a paper on the geology of the San Gabriel Mountains, which he presented before the Geological Society of America at Berkeley. Mr. Kew also prepared a paper entitled "A geologic time scale for a part of southern California," presented at the meeting of the American Association of Petroleum Geologists in Denver.

Publications.—Issued: Bulletins 724, 735-J; press notice on nitrate in southeastern California; oil and gas map of California.

COLORADO.

Field work.—J. B. Reeside, jr., accompanied a topographic party mapping the canyon of Green River, Colo., and examining dam and reservoir sites along the stream for the development of power and for irrigation. J. D. Sears, assisted by James Gilluly and W. H. Bradley, did geologic mapping in Moffat County.

ome details of structure that may have a bearing on the accumulation of oil were mapped. J. B. Eby began field work in the eastern Yampa coal field, doing detailed mapping between Craig and Hayden. G. F. Loughlin made a brief visit to the Leadville district to obtain data for the completion of a report on the district.

Office work.—C. W. Cross, E. S. Larsen, C. S. Ross, and Kirtley Mather continued preparation of reports on the geology of the San Juan region. F. H. Nowlton submitted a paper on the Animas flora as a shorter contribution to general geology. G. F. Loughlin continued the revision of the Leadville monograph. E. S. Larsen made some progress on his report covering the geology of the San Cristobal quadrangle. J. D. Sears and W. H. Bradley prepared and submitted a paper on the relations of the Wasatch and Green River formations in northwestern Colorado and completed a report on the geology and oil and gas prospects of a part of Moffat County, Colo., and southern Sweetwater County, Wyo. J. B. Reeside, jr., completed a report on the Cretaceous and Tertiary formations of the west side of the San Juan Basin of Colorado and New Mexico. A report by W. T. Lee on the correlation of the oil-bearing rocks of eastern Wyoming and Colorado was prepared and published. Paleontologic reports on material from Colorado were made by T. W. Stanton, G. H. Girty, and W. H. Dall.

Publications.—Issued: Bulletins 707, 729, 735-D, 751-A; Professional Papers 130, 131-F, 131-G, 131-H; Geologic Folio 214; press notice announcing publication of Bulletin 751-A. In press: Bulletin 718, "Geology and ore deposits of the Creede district, Colo."

DISTRICT OF COLUMBIA.

Field work.—C. K. Wentworth continued field studies of the terrace gravels of the Coastal Plain in the District of Columbia and vicinity.

Office work.—Papers were prepared and presented by L. W. Stephenson, Laurence La Forge, C. K. Wentworth, and E. W. Berry, discussing the geologic section exposed in the excavation for the new Walker Hotel. C. K. Wentworth submitted a report on the Coastal Plain terrace gravels, including those of the District. The publications of the year included a shaded road map of the country around Washington, bearing on the back a historical and geologic text.

FLORIDA.

Field work.—A reconnaissance examination of the Government phosphate lands in Florida was made by G. R. Mansfield and G. W. Holland to procure data for land classification.

Office work.—T. W. Vaughan studied fossil Foraminifera from the Eocene and Miocene formations of the Coastal Plain of Florida. Work on a report on the upper Oligocene formations of Florida and southern Alabama was continued by W. Cooke, who also prepared a paper on the Flint River formation in Florida and adjacent States. Julia Gardner completed and submitted the final draft of Parts I and II of a report on the Mollusca of the Alum Bluff formation of Florida and continued the preparation of Part III. W. C. Mansfield prepared a paper entitled "A contribution to the late paleontology of northwestern Florida."

GEORGIA.

Field work.—C. W. Cooke and L. W. Stephenson did supplementary field work in the Cretaceous, Tertiary, and Quaternary formations of Georgia and made brief examinations of the oil and gas possibilities in the vicinity of Fort Valley, with T. M. Prettyman, of the State Survey.

Office work.—A paper on the Flint River formation, a new division of the Icksburg group, was prepared by C. W. Cooke. Some work was done by Laurence La Forge on a bulletin on the physical geography of Georgia.

IDAHO.

Field work.—Dam sites on the King Hill project, Idaho, were examined for the Reclamation Service by F. C. Calkins. In cooperation with the State of Idaho, the field study of the geology and ore deposits of the region adjacent to Talache and the south arm of Lake Pend Oreille was continued by Edward

Sampson and J. L. Gillson. Field work in the Portneuf and Paradise Valley quadrangles, with special reference to the study of the phosphate lands, was begun by G. R. Mansfield.

Office work.—Preparation of a joint report by Edward Sampson and J. L. Gillson on the geology and ore deposits in the vicinity of Lake Pend Oreille has been in progress. G. R. Mansfield completed and transmitted for publication a report on the geography, geology, and mineral resources of part of southeastern Idaho. He also prepared for outside publication a paper on the structure of the Rocky Mountains in Idaho and Montana. Paleontologic material from various formations was studied and reported on by T. W. Stanton, G. H. Girty, W. H. Dall, and Edwin Kirk. F. H. Knowlton studied specimens and began the preparation of descriptions of plants from beds supposed to be interbedded with the Columbia lava of Idaho and Washington. A short paper on possible oil in Idaho was written by K. C. Heald and was published in the Bulletin of the American Association of Petroleum Geologists.

Publications.—Issued: Bulletin 732.

ILLINOIS.

Field work.—Frank Leverett made field examinations along the southern border of the Kansan and Nebraskan glacial drift sheets in Missouri and Illinois.

Office work.—A cooperative bulletin on the Equality and Shawneetown quadrangles, Illinois, to be published by the State, was completed by Charles Butts.

KANSAS.

Office work.—A paper on the drift of Missouri and Kansas was prepared by Frank Leverett for presentation at the meeting of the Geological Society of America at Ann Arbor, Mich.

KENTUCKY.

Field work.—E. O. Ulrich spent several days in central Kentucky gathering faunal and stratigraphic data.

Office work.—Some progress was made on the preparation of a geologic folio on the Shawneetown and Equality quadrangles by Charles Butts. E. O. Ulrich continued studies of Trenton and Cincinnati faunas and notes on stratigraphic sections in middle Tennessee and central Kentucky, with the primary purpose of preparing a report (jointly with R. S. Bassler) on the stratigraphy and fossil faunas of middle Tennessee. Results of these studies were incorporated in a paper delivered before the Paleontological Society at Ann Arbor in December. K. C. Heald reviewed and transmitted the oil and gas map of Kentucky and prepared a press bulletin announcing its publication. Plant remains collected by David White from the Devonian rocks of eastern Kentucky were found by Taisia Stadnichenko, chemist at Vassar College, to be richly bituminous. They are described in a paper entitled "Some mother plants of petroleum in the Devonian black shales," read before the Association of Economic Geologists and printed in Economic Geology.

Publications.—Issued: Map of oil and gas fields of Kentucky.

LOUISIANA.

Office work.—M. I. Goldman studied salt-dome cap rocks and made preliminary microscopic examinations of a salt-dome core from Sulphur, La. E. W. Berry, T. W. Stanton, and Julia Gardner studied fossil collections from Louisiana.

MAINE.

Field work.—Laurence La Forge and F. J. Katz made brief inspections in the Portland quadrangle, Maine, in connection with the Portland geologic folio, which is in preparation.

Office work.—Arthur Keith continued work on the contour map of Maine for the New England geographic handbook.

MARYLAND.

Field work.—David White and W. T. Thom, jr., did some stratigraphic work on the Mount Savage fire-clay deposits and on the coal measures of Georges Creek coal basin, Maryland and West Virginia. Some rock samples were collected for determinations of gravity. Work in Carroll County was continued by Miss A. I. Jonas for the Maryland Geological Survey. C. K. Wentworth made studies of Coastal Plain gravels and terraces in Maryland.

MISSISSIPPI.

Office work.—L. W. Stephenson completed two cooperative reports on the State of Mississippi, one on the geology, to be published by the State Survey, and one on the ground waters, for publication by the United States Geological Survey.

MISSOURI.

Field work.—Frank Leverett made field examinations along the southern border of the Kansan and Nebraskan glacial drift sheets in Missouri and western Illinois. E. O. Ulrich, assisted by R. D. Mesler, did stratigraphic work and made paleontologic collections in the Eminence and Potosi quadrangles, Mo., and C. E. Siebenthal did some field work in the Wyandotte quadrangle.

Office work.—E. O. Ulrich reported upon Ozarkian fossils for the Missouri State Survey. W. T. Thom, jr., prepared a text on the geology of the coal formations of Missouri, to be published in a Bureau of Mines technical paper on analyses of Missouri coals. A paper on the drift of Missouri and Kansas was prepared by Frank Leverett for presentation at the meeting of the Geological Society of America at Ann Arbor, Mich.

MONTANA.

Field work.—C. E. Dobbin and J. B. Reeside, jr., studied the Fox Hills sandstone and the Lance formation and their relations in southeastern Montana, southwestern North Dakota, and northwestern South Dakota. H. A. C. Jenison made field studies of manganese ore deposits in western Montana. K. C. Heald and W. W. Rubey mapped the structure of the Ingomar dome. R. S. Knappen, assisted by G. F. Moulton and H. H. Charles, completed field mapping in the northern Big Horn Basin. Frank Reeves, assisted by M. N. Bramlette and M. I. Goldman, continued areal and economic work in Blaine and Chouteau Counties. C. E. Dobbin, assisted by J. E. Hoffmeister and A. H. Redfield, mapped the areal geology and workable lignite beds in McCone County and began with several assistants systematic mapping of the Gangue River and Armells Creek coal fields. W. C. Alden studied the Tertiary (?) and Pleistocene bench gravels in Yellowstone Valley and tributaries and the associated glacial phenomena in the western part of the State. A. J. Collier, assisted by W. W. Boyer and Ralph Lusk, mapped the Kevin-Sunburst area and adjacent parts of the Sweetgrass arch.

Office work.—W. C. Alden continued the preparation of his report on the Cenozoic history of eastern Montana, prepared a paper on the physiographic development of the northern Great Plains, and wrote a popular article on Sun River canyon, a note for Science on the rate of movement of glaciers in Glacier National Park, and a brief report on Grasshopper Glacier, near Cooke, for the National Park Service. J. T. Pardee continued work on a report on glaciation and the origin of gold-bearing gravels in the Pioneer region and completed a report on the geology and ground water of Townsend Valley for the water-resources branch. Work on his final report on the geology and oil and coal resources of the Crow Indian Reservation was continued by W. T. Thom, jr., who also assembled material for a map showing the geologic structure of the Dakota sandstone in Montana and revised his paper on the relation of deep-seated faults to surface structural features of central Montana, which was published by the American Association of Petroleum Geologists. A report on the geology and oil and gas possibilities of the faulted area south of the Bearpaw Mountains, by Frank Reeves, was transmitted for publication. Mr. Reeves also presented a paper on geological structure of the Bearpaw Mountains at a meeting of the Geological Society of Washington. A press notice and sketch structure map of the Kevin-Sunburst district were prepared by

A. J. Collier, who also continued work on his report on the geology of the Fort Belknap Indian Reservation and the Little Rocky Mountains. He presented a paper on the geology of the Little Rocky Mountains before the Geological Society of Washington. R. S. Knappen and G. F. Moulton made some progress on a report on the geology and oil possibilities of the northern Big Horn Basin. Mr. Moulton completed the maps and text for a press notice on oil and gas prospects north of the Pryor Mountains. C. E. Dobbin completed a report on the geology and coal resources of parts of Garfield, McCone, and Dawson counties, and began the preparation of a paper on the Lance and Fort Union formations of the Missouri River valley for outside publication. G. R. Mansfield completed a paper on the structure of the Rocky Mountains in Idaho and Montana and transmitted it for publication in the Bulletin of the Geological Society of America.

Publications.—Issued: Bulletins 736-B, 736-F; Press notice, "Results of an examination by a Government geologist on the Kevin-Sunburst oil field, Mont."

NEVADA.

Field work.—H. G. Ferguson, assisted by S. H. Cathcart, continued field study and geologic mapping of the Tonopah and Hawthorne quadrangles, Nev. Lewis G. Westgate, assisted by Carle H. Dane, began field work in the Pioche mining district. F. L. Ransome, assisted by H. A. C. Jenison, made a study of the geologic problems of the Boulder and Black Canyon dam sites for the Reclamation Service. D. F. Hewett completed field work in the Goodsprings quadrangle.

Office work.—H. G. Ferguson and S. H. Cathcart began a joint preliminary report on the geology and mineral resources of the Tonopah quadrangle. F. C. Schrader prepared a revised report on the Jarbridge district and has in preparation a report on the ore deposits of the Carson Sink region. Adolph Knopf completed and transmitted a report on the geology and ore deposits of the Rochester district. D. F. Hewett prepared a paper on the structure of the Spring Mountain Range for the meeting of the Geological Society of America at Ann Arbor, Mich. He also reported on alum deposits near Fallon and carnotite in southern Nevada, and prepared a brief report on pickeringite near Fallon and a press notice on ground water in the Piute Valley. T. W. Stanton, G. H. Girty, W. H. Dall, and Edwin Kirk studied and reported on fossil material from various formations.

Publications.—Issued: Bulletin 741; press notice on ground water in the Piute Valley. In press: "Geology and ore deposits of the Manhattan district" (Bulletin 723).

NEW MEXICO.

Office work.—J. D. Sears revised his report on the Gallup-Zuni coal field, N. Mex., and transmitted it for publication. H. G. Ferguson continued the preparation of his final report on the geology and ore deposits of the Mogollon district. At the request of the Reclamation Service E. S. Larsen prepared a report on the geology of the drainage area of the Rio Grande in northern New Mexico. W. T. Lee completed the revision of his report on the coal resources of the Raton district. J. B. Reeside, jr., prepared data on the sub-surface geology in San Juan Basin in Colorado and New Mexico, and worked on a paper on the Cretaceous and Tertiary formations of the western part of the basin.

Publications.—Issued: Geologic Folio 214; Prof. Paper 122.

NEW YORK.

Office work.—Some progress was made by L. M. Prindle on the geologic maps and manuscripts for the Berlin-Greylock and Hoosick-Bennington folios. David White spent some time in study of spores in Devonian black shale from New York to ascertain facts to be set forth in a paper on the mother plants of petroleum in the Devonian black shale.

NORTH CAROLINA.

Field work.—L. W. Stephenson and C. W. Cooke did supplemental field work on Cretaceous, Tertiary, and Quaternary formations in North Carolina in connection with reports being prepared by Mr. Cooke. M. R. Campbell and

K. K. Kimball examined the Deep River coal field in cooperation with the State and made a reconnaissance examination of a reported coal field in Montgomery County.

Office work.—W. S. Bayley spent some time revising a manuscript on magnetite iron ores of western North Carolina and eastern Tennessee, prepared in cooperation with the two State geological surveys. G. R. Mansfield revised a report on the origin of the Brown Mountain lights, published as a press notice. A report on the Deep River coal field was completed by M. R. Campbell and K. K. Kimball and transmitted to the State for publication. A paper on the Ore Knob copper mine of North Carolina was prepared by C. S. Ross. W. C. Mansfield studied fossil collections from North Carolina.

Publications.—Issued: Bulletins 735-F, 735-G.

NORTH DAKOTA.

Field work.—C. E. Dobbin, accompanied by J. B. Reeside, jr., visited localities important for a general study of the Fox Hills sandstone and Lance formation in southeastern Montana, southwestern North Dakota, and northwestern South Dakota.

Office work.—W. T. Thom, jr., prepared a press notice on the oil and gas possibilities of northwestern North Dakota.

Publications.—Issued: Press notice on oil and gas possibilities in northwestern North Dakota.

OHIO.

Office work.—W. T. Thom, jr., prepared a press notice announcing the publication of a report by D. D. Condit on the economic geology of the Sumnerfield and Woodsfield quadrangles, Ohio. M. R. Campbell prepared a report on the geology of the Ohio coal fields, for the Bureau of Mines.

Publications.—Issued: Bulletin 720; press notice announcing Bulletin 720

OKLAHOMA.

Field work.—A. F. Melcher visited the Burbank oil field, Okla., to continue his studies of the porosity of samples of rock from oil fields. K. C. Heald did some field mapping in sec. 11, T. 24 N., R. 6 E., Osage County, and prepared a map and report covering this work for the Office of Indian Affairs. C. E. Siebenthal examined mines in the Wyandotte quadrangle.

Office work.—K. C. Heald wrote press notices announcing the publication of Bulletin 736-A and Bulletin 686-Z. A manuscript for a bulletin on the geology of the Bristow quadrangle, Creek County, Okla., with reference to petroleum and natural gas, by A. E. Fath, was revised by Mr. Heald and transmitted for publication. A. F. Melcher determined the pore space and diameter of grains in samples of oil sand from the Burbank field. P. V. Roundy and G. H. Girty completed a paper on the Glenn formation of Oklahoma. H. D. Miser began the compilation of data for a geologic map of Oklahoma. C. S. Ross prepared a paper on the evidence of slumping preserved in Pennsylvanian beds of Oklahoma for publication in the Journal of Geology.

Publications.—Issued: Bulletins 686-Z, 686, 730-D.

OREGON.

Field work.—F. C. Calkins made a field examination on dam sites on the Umatilla project, Oreg., for the Reclamation Service. W. S. W. Kew made a field examination of the geology of Ashland and vicinity, with reference to the oil-shale deposits and oil possibilities.

Office work.—J. S. Diller prepared a brief supplementary paper on the engulfment of Mount Mazama. W. S. W. Kew reported on the deposits of oil shale near Ashland.

PENNSYLVANIA.

Field work.—Examinations were made in the Honeybrook, Phoenixville, Coatesville, and West Chester quadrangles, Pa., by Florence Bascom and G. W. Stose and in the New Holland and Lancaster quadrangles by A. I. Jonas and Mr. Stose. Mr. Stose also spent some time in Adams County and Chester Valley on work for the State Survey. Charles Butts carried on field work in the

Belleville, Hollidaysburg, and Huntingdon quadrangles, in connection with the preparation of geologic folios on these quadrangles. G. B. Richardson examined coal fields in the Somerset and Windber quadrangles. David White made field studies of the Mercer group in several counties and collected fossil plants in connection with an investigation of the relations of that group in western Pennsylvania and the Brookville group farther east.

Office work.—A. I. Jonas and E. B. Knopf continued work on the Quarryville-McCalls Ferry report. Miss Jonas completed a brief paper on the Quarryville quadrangle for a bulletin to be published by the State Survey of Pennsylvania. G. B. Richardson, K. K. Kimball, and A. A. Baker devoted some time to work on the report covering the geologic structure and coal, oil, and gas conditions in the New Kensington quadrangle. Florence Bascom completed her portions of the Coatesville-West Chester, Honeybrook-Phoenixville, Reading-Boyertown, and Quakertown-Doylestown geologic folios. G. W. Stose gave some time to the preparation of maps, text, etc., to be used in the two first-named folios, of which he is joint author. Miss Jonas contributed a short report on the diabase of the Quakertown and Doylestown quadrangles to be incorporated in the folio covering those quadrangles. Charles Butts completed the revision of the Hollidaysburg-Huntingdon folio. A paper on the crystalline schists of Pennsylvania and Maryland was submitted by Mrs. Knopf for publication in the American Journal of Science. Miss Jonas and Mr. Stose prepared a paper on the Ordovician overlap of the Piedmont in Pennsylvania and Maryland for presentation at the meeting of the Geological Society of America.

SOUTH CAROLINA.

Field work.—L. W. Stephenson and C. W. Cooke made field studies of the Coastal Plain terraces in South Carolina.

Office work.—C. W. Cooke resumed work on his report on the geology of the Coastal Plain of South Carolina. L. W. Stephenson identified and prepared a list of Cretaceous fossils from Mars Bluff, Pee Dee River, for use in Mr. Cooke's report. J. B. Reeside, jr., prepared a paper on *Eutrepoceras sloani*, a new nautiloid cephalopod from the Eocene of South Carolina, to be published by the United States National Museum.

SOUTH DAKOTA.

Field work.—C. E. Dobbin, accompanied by J. B. Reeside, jr., made a trip through southeastern Montana, southwestern North Dakota, and northwestern South Dakota, visiting localities important for a general study of the Fox Hills sandstone and Lance formation. Sidney Paige did some additional field work in connection with the preparation of his report on the Homestake mine.

Office work.—The Black Hills folio text, by Sidney Paige and N. H. Darton, was subjected to final revision. Sidney Paige's report on the geology in the vicinity of Lead, S. Dak., and its bearing on the Homestake mine was transmitted for publication. He presented a paper on the Homestake mine at the meeting of the Geological Society of America at Ann Arbor.

TENNESSEE.

Field work.—E. F. Burchard began field work on the brown iron ores of western Tennessee in cooperation with the Tennessee Geological Survey. Burchard, C. W. Cooke, and L. W. Stephenson examined the Coastal Plain formations along the Tennessee-Mississippi boundary with State Geologist W. A. Nelson.

Office work.—W. S. Bayley revised the manuscript of a report on the magnetite ores of eastern Tennessee and western North Carolina prepared in cooperation with the two State surveys. D. F. Hewett prepared a paper on the relation of manganese oxide deposits of Virginia and Tennessee to peneplains for unofficial publication. E. O. Ulrich made studies of Trenton and Cincinnati faunas and their stratigraphic relations in middle Tennessee and central Kentucky for a report (with R. S. Bassler) on the stratigraphy and fossil faunas of middle Tennessee. Some of the results of these studies were incorporated in a paper delivered before the Paleontological Society at Ann Arbor. The report on the geology and ore deposits of the Ducktown mining district, by W. H. Emmons and F. B. Laney, has been submitted for publication as a professional paper. H. D. Miser prepared a paper on iron ore on a peneplain in

the Waynesboro quadrangle, which was read at the New York meeting of the Society of Economic Geologists. Charles Butts prepared a report on a marble belt in the vicinity of Knoxville.

Publications.—Issued: Bulletins 735-G, 737.

TEXAS.

Field work.—H. W. Hoots continued field work in western Texas in connection with explorations for potash salts until September, 1922, when W. B. Lang assumed this task. Julia Gardner continued her work on the Midway and Wilcox formations of the State, examining collections at the University of Texas, Austin, in cooperation with the State Bureau of Economic Geology and technology.

Office work.—G. R. Mansfield completed a paper on the potash field in western Texas, which was published in *Industrial and Engineering Chemistry*, May, 1923. Julia Gardner continued her work on her part of the final report on southwestern Texas. L. W. Stephenson began a report on the formations of the Gulf series between Colorado River and the Rio Grande. K. C. Heald wrote press notice on the Wiles area and one announcing Bulletin 736-G. P. V. Lounchy worked on a report on the microscopic fauna of the lower Bend of Texas. This report is designed particularly for the guidance of oil-company paleontologists.

Publications.—Issued: Professional Paper 131-D; Bulletins 730-D, 736-E, 36-G.

UTAH.

Field work.—E. M. Spieker, assisted by J. B. Eby in 1922 and A. A. Baker in 1923, made a detailed examination of the geology and coal resources of portions of the Wasatch Plateau between Salina and Price River canyons, Utah. R. C. Moore, in connection with coal-classification work in southern Utah, mapped geologically a large area north of Colorado River from Paria Creek eastward. H. E. Gregory and L. F. Noble made a reconnaissance from Kanab Creek eastward to connect with Mr. Moore's work. J. B. Reeside, jr., accompanied a topographic party making a survey of Green River with reference to reservoir sites for power and reclamation projects.

Office work.—H. D. Miser, Sidney Paige, and K. W. Trimble prepared a report on the Rainbow Natural Bridge for outside publication. A report by C. R. Longwell, H. D. Miser, R. C. Moore, Kirk Bryan, and Sidney Paige, entitled "Rock formations in the Colorado Plateau of southeastern Utah and northern Arizona," was submitted for publication. Mr. Miser brought nearly to completion a report on the structure of the San Juan Canyon and adjacent areas. He also prepared administrative reports on the geologic aspects of engineering problems along San Juan and Colorado rivers in southeastern Utah. Frank R. Clark submitted a report under contract on the economic geology of the Sunnyvale and Wellington quadrangles. E. M. Spieker prepared a map and reports on the land-classification branch on work done in the Wasatch Plateau coal field in 1922 and a paper on the geology of the coal fields of Utah to accompany the report of the Bureau of Mines on the analyses of Utah coals. F. C. Calkins made some progress on a report on the general geology of the Cottonwood district. R. C. Moore spent several days on maps and a report on land classification in southern Utah. F. L. Hess prepared and transmitted a paper on ilsemanite at Ouray. J. B. Reeside, jr., completed a paper on the geology of the Green River valley between Green River, Wyo., and Green River, Utah.

Publications.—Issued: Professional Paper 131-F.

VERMONT.

Office work.—L. M. Prindle continued the preparation of the folio covering the Hooisick and Bennington quadrangles, Vt. Arthur Keith submitted a report on the stratigraphy of northwestern Vermont for outside publication.

VIRGINIA.

Field work.—David White and J. B. Eby worked in the Wise County coal field, Va., revising and correcting geologic boundaries of Pennsylvanian and Mississippian rocks on the south side of Powell Mountain. G. F. Loughlin examined stone available for construction work on the Government reservation at

Quantico and vicinity. Charles Butts examined, in cooperation with the State Survey, reported occurrences of oil at Rose Hill. C. K. Wentworth examined Coastal Plain gravels and terraces. M. R. Campbell and K. K. Kimball mapped the structure, areal geology, and coal outcrops of the Price Mountain district, near Blacksburg, in cooperation with the State Survey. E. O. Ulrich studied Upper Cambrian, Ozarkian, Canadian, and Ordovician formations in the Appalachian Valley. He also obtained some information regarding Clinton and Devonian beds.

Office work.—W. C. Mansfield continued the preparation of a report on the Miocene stratigraphy of Virginia. J. B. Eby completed his report on the coal resources of Wise County, prepared in cooperation with the State Survey, and submitted it to the State for publication. G. W. Stose contributed a chapter for this report on the Big Stone Gap area. Mr. Eby also prepared a paper on the possibilities of oil and gas occurrence in southwestern Virginia, showing the relation of isocarbs to faulting. This paper was presented in March, 1923, at the meeting of the American Association of Petroleum Geologists in Shreveport, La. W. T. Lee completed a report on the geography of the Coastal Plain of Virginia for the State Survey. M. R. Campbell prepared a description of the Virginia coal fields for the Bureau of Mines. Charles Butts prepared a press report with map covering his investigations of the oil well and the geology of the surrounding area at Rose Hill. D. F. Hewett prepared a paper on the relation of the manganese oxide deposits of Virginia and Tennessee to peneplains, for unofficial publication.

WASHINGTON.

Office work.—F. H. Knowlton continued the study of fossil plants from Spokane, Wash., interbedded with Columbia lava. J. T. Pardee completed an introduction to a report by Mr. Knowlton on these plants.

WEST VIRGINIA.

Field work.—David White and W. T. Thom, jr., collected rock samples for determinations of gravity and did stratigraphic work on the coal measures of the Georges Creek basin in Maryland and West Virginia.

Office work.—J. B. Eby wrote a report on the geology and coal formations of West Virginia for inclusion in the Bureau of Mines technical paper on analyses of West Virginia coal. G. H. Girty prepared a paper on the Chester group of West Virginia for the Tucker County report of the State Survey and worked on a paper on the fauna of the Greenbrier limestone.

Publications.—Issued: Map of oil and gas fields of West Virginia.

WISCONSIN.

Field work.—Frank Leverett studied the glacial drift sheets north of the Driftless Area and investigated the pre-Wisconsin drift sheets and associated deposits.

Office work.—E. O. Ulrich prepared a paper entitled "Table of the geological formations in Wisconsin" and submitted it to the Wisconsin Geological Survey.

WYOMING.

Field work.—C. R. Longwell, W. W. Rubey, Alexander Stepanoff, and H. W. Hoots made field studies in Crook and Weston counties, Wyo., as part of a detailed study of the oil possibilities of the Black Hills rim. A. J. Collier, assisted by W. W. Boyer, mapped the Golden Eagle gas field, northwest of Thermopolls, and a number of structural features in the vicinity of Casper. J. B. Reeside, jr., accompanied an engineering party mapping the Green River canyon from Green River, Wyo., to Green River, Utah. J. D. Sears and W. H. Bradley completed field mapping in Sweetwater County, an extension of the project covering Moffat County, Colo., and began a detailed study of the Baxter Basin. Mr. Bradley, assisted by Carle H. Dane, examined deposits of oil shale in the vicinity of Steamboat Mountain, Sweetwater County.

Office work.—J. D. Sears and W. H. Bradley completed a report on the geology and oil and gas prospects of a part of Moffat County, Colo., and southern Sweetwater County, Wyo., and another on the relations of the Wasatch and Green River formations in northwestern Colorado and southern Wyoming.

D. F. Hewett worked on the text and illustrations of a report on the geology and resources of Oregon Basin, in the Meeteetse and Grass Creek quadrangles, Wyo., with particular reference to coal. C. R. Longwell and W. W. Rubey completed a press notice, accompanied by a contour map, of the Pump Creek antiline, near the Osage field. J. R. Reeside, jr., wrote a report on the geology of the Green River canyon from Green River, Wyo., to Green River, Utah. A. J. Collier prepared a press notice, map, and illustrations covering five domes in the Bates Hole district, Natrona County.

Publications.—Issues: Bulletins 736-D, 751-A.

EUROPE, ASIA, AND AFRICA.

Office work.—David White prepared a joint report with H. C. Morris, of the Department of Commerce, on progress in oil development in Europe, Asia, and Africa, which was presented before the American Institute of Mining and Metallurgical Engineers in February, 1923.

HAITI.

Office work.—W. P. Woodring, assisted by J. S. Brown and W. S. Burbank, continued work on the report on the geology of the Republic of Haiti, the expenses of which were borne by the Haitian Government. A report on the mineral deposits of Haiti was prepared by W. S. Burbank.

HAWAII.

Office work.—W. H. Dall completed and reviewed the monograph of Hawaiian marine Mollusca.

DIVISION OF MINERAL RESOURCES.

In the division of mineral resources the year was characterized chiefly by additional activities and changes imposed by the situation in the coal industry and was marked further by the completion of the delayed annual reports on mineral fuels for the years 1919, 1920, and 1921, so that at the end of the fiscal year all work was again "current." The division suffered further losses in its technical personnel, but these losses were partly offset by transfers within the Survey and by the fact that the funds thus freed were used to increase the clerical force by one permanent employee and several temporary employees. Thus, although the losses were serious, they made it possible to expedite the routine work on the longer statistical tasks, particularly the annual coal and petroleum canvasses, and to devote more of the division's funds to field canvasses on the coal industry than during the preceding year.

Despite the gain thus indicated, however, the inadequacy of personnel and funds was keenly felt. The section of nonmetals particularly suffered from lack of technically trained supervisors or specialists on at least 10 subjects, although it has been fortunate in obtaining by assignment the services of G. R. Mansfield as specialist in phosphate rock, potash, and nitrates as successor to the specialist who resigned more than a year ago. Through inability to handle certain subjects as they should be handled the Survey is not only gradually losing ground in these fields but is becoming less able to serve the Government or individuals with complete and up-to-date information and with reliable judgment.

Eight separations in the division's force occurred during the year—four resignations, two retirements, and two transfers. Five of these separations were among the clerical force and have been offset

by transfer from other divisions and new appointments. Three separations occurred in the technical force. E. G. Sievers resigned July 7, 1922, as specialist on natural gas and derived products. Mr. Sievers's place has not been filled, but his work has been added to that of the petroleum specialist, to whom has been given one additional permanent clerk. On December 31, 1922, Charles G. Yale, statistician in charge of the San Francisco branch office since 1903, retired. Mr. Yale was an authority on the metal-producing industry of the Pacific Coast States, regularly contributed creditable papers to the Survey's publications, and had been eminently successful in maintaining cordial relations with the mining public. He was succeeded by J. M. Hill, geologist. F. G. Tryon was transferred November 16, 1922, to the United States Coal Commission, the connection between the Survey's work on coal and coke statistics and the commission's work thus being established advantageously to both offices. Mr. Tryon is expected to return to the Survey on completing his assignment with the Coal Commission, and his place is being partly filled temporarily by F. J. Katz. For most of the year Mr. Katz was in charge of the division, relieving G. F. Loughlin, whose services were required primarily for geologic work.

The available office space has been even more crowded than heretofore, owing to the growth of records and files in current use and to the increase in the desk space needed for temporary clerks and for the clerks working in connection with the United States Coal Commission and the Federal fuel distributor's inquiries. The specialists accommodated in the space provided for the division and section chiefs have, as heretofore, been obliged to share their offices with two or more clerks and on account of congestion are hindered in their work and in properly caring for persons who call at the Survey for information.

Public interest during the year centered largely in the work on fuels. Weekly reports were prepared and issued on the country's production of coal and monthly reports on the production of petroleum and cement. The petroleum section of the division, in addition to doing its routine work and catching up with delayed work, prepared a large amount of statistical material on the production, stocks, and prices of crude oil for the use of the Senate Committee on Manufactures in its investigations relating to the cost of gasoline. The coal section carried on and brought up to date its usual work. It also assisted the President's unemployment conference in studies of fluctuations in the coal industry and of coal marketing. While the great strike was in force it prepared for distribution, chiefly to Federal and State officials, daily reports on coal production and shipments and semiweekly statements for the use of the President and Cabinet. It also rendered assistance to the Federal fuel distributor's office and, in cooperation with the Bureau of the Census, undertook for that office five canvasses of consumers' stocks of coal, on which reports have been issued. These extraordinary undertakings necessitated the assignment of Mr. Katz to the coal-statistics section and consequent postponement of his regular work on nonmetals.

Work on metals continued as in recent years with slight additional tasks in compilation of producer lists for the Bureau of Internal Revenue and for the Senate Commission on Gold and Silver Inquiry.

Work of the nonmetals section was reduced to essential routine statistical inquiries and compilations.

Cooperation with the Bureau of the Census in the field of the division's regular statistical inquiries was restricted to a few subjects covered in the 1921 biennial census of manufactures, as outlined in the Director's report of a year ago.

Cooperation with the State geological surveys continued as heretofore. The number of cooperating States during the fiscal year was 16.

The work of the western offices continued in the main as usual. Besides the statistical work of the San Francisco office Mr. Hill had opportunity for a small amount of geologic field work in California. The demand on the office for statistical work required additional clerical help for a period of two months. At the Salt Lake City office C. N. Gerry acted in charge for about six months, while V. C. Heikes was engaged in the study of supplies of arsenic. During part of that time Mr. Heikes was at Birmingham, Ala., where he was in close touch with agriculturists and others interested in the problem of obtaining arsenic.

The section of foreign mineral reserves continued to supply timely information on foreign mineral production, reserves, and developments, especially on oil. A large amount of statistical and bibliographic material was added to its files. Toward the end of the year the work of the section was reorganized and reduced in order to expedite the preparation of atlases showing fuel reserves.

Progress in compilation of the annual chapters of Mineral Resources of the United States compares favorably with recent years. Part I of the volume for 1921 was sent to the printer in June. The final chapter of Part II, on coal, was sent to the printer in March. During the year 30 chapters of the volume for 1921 were transmitted, including a chapter on foreign mineral production, which is new to the series, and 25 chapters of the volume for 1922. Those for 1922 still incomplete include subjects that involve handling a large number of producers' reports and can not be completed earlier without more prompt cooperation from the producers; also some of the minor reports on nonmetals, which the chief of the section could not prepare because of other duties but on which the statistical work is practically complete. The preliminary summary of mineral resources in 1922 was transmitted March 31 and published August 15, 1923; the corresponding summary for 1921 was transmitted April 1 and published September 14, 1922. As for the year preceding, most of the reports for 1922 have been much curtailed, primarily to keep within the reduced printing fund, also because the scope of many of them has become so stabilized that much of the discussion of the statistical tables is no longer necessary, and partly because in the absence of specialists assigned to certain subjects only statistical material was available for publication.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

The work of the division of chemical and physical research was carried on under an appropriation of \$3,000 for the salary of one chemist and a lump-sum appropriation of \$40,000 for laboratory

expenses, the salaries of chemists, physicists, and assistants, and expenses incident to the search for potash. The field expenses in the search for potash were approximately \$5,500. The personnel comprised 14 persons and remained without change during the entire year. George Steiger, chief chemist, acted as chief of the division and also directed the work of the chemical laboratory. C. E. Van Orstrand directed the work of the physical laboratory.

The division is charged with the responsibility of aiding the study of geologic processes by conducting researches in chemistry, physics, and mineralogy, by making chemical analyses of rocks, minerals, ores, and waters, and by carrying out physical measurements and observations in both field and laboratory.

WORK IN CHEMISTRY.

The section of chemistry has continued a service to the public in identifying 2,085 specimens sent in by persons from all parts of the country. Most of the specimens were identified by simple inspection. Quantitative analyses numbered 673 and were made mainly for use in geologic investigations.

A paper on the evolution and disintegration of matter was prepared by F. W. Clarke for publication. This paper is an elaborate discussion of the evolution of the elements from nebula to planet, including a discussion of the reverse process of stellar disintegration and a discussion of the average composition of the earth.

Supplemental experiments were made on the effect of nitric acid on granite by George Steiger. Mr. Steiger also examined the pebble-phosphate workings of Polk County, Fla., and prepared a brief report on that industry. After a study of conditions to be satisfied a method for the analysis of sediments was outlined by Mr. Steiger and J. G. Fairchild. During the year the method was practically applied, with satisfactory results, to the analysis of 68 bottom samples from the Bay of Maine and from the vicinity of Samoa.

An exhaustive study of the chemical changes by which metallic copper may be formed in nature, with particular reference to the Lake Superior region, was begun by R. C. Wells, who visited the mines early in the year for the purpose of collecting samples and who later prepared and read a paper on the subject before the Ann Arbor meeting of the Geological Society of America in December, 1922. At this meeting Mr. Wells also read a paper on the flocculation of colloids before the conference on sedimentation. Mr. Wells finished revision of the manuscript on sodium sulphate, which was published as Bulletin 717. An address on the chemistry of the sea was given by Mr. Wells before the Chemical Society of Washington.

A wax from the Elko oil shale was separated and studied by E. T. Erickson, who also studied bituminization in cannel coal and made a careful investigation, including laboratory experiments, to show the nature of the hydrocarbons of a submerged forest found in excavating for a new hotel at Washington, D. C.

W. T. Schaller investigated a number of rare and unusual minerals and described one new species, argentojarosite. He continued the study of uranium and vanadium minerals and of pegmatites and prepared a paper on this subject and examined in the field pegmatites in North Carolina, Maryland, and Pennsylvania. The sillic acid derived from the mineral gillespite was further studied in conjunction with X-ray spectra. Field studies were made of copper-cobalt minerals in Maryland, graphite and quartz in North Carolina, crystallized turquoise in Virginia, and the zeolite region in New Jersey. Measurements of openings in ordinary laboratory screens again demonstrated the wide variance in size of holes in screens of certain mesh. Mr. Schaller also assisted and partly supervised E. P. Henderson in the inspection and identification of many specimens of minerals, rocks, and ores.

Field work in the search for potash is described in the report of the division of geology. There was a decided decrease in the number of samples received for assay owing to the fact that a number of wells now being put down with the core drill in order to obtain more reliable samples have not yet reached the salt dome. R. K. Bailey determined necessary conditions for flame tests for potash, including tests of the limits of error.

WORK IN PHYSICS.

C. E. Van Orstrand made observations of temperature in 128 springs and geysers in Yellowstone National Park. A report on these observations, entitled "Temperatures in some springs and geysers in Yellowstone National Park," has been submitted to the American Geophysical Union for publication with other papers on thermal springs. The preparation of the extended paper on deep earth temperatures of the globe was continued at intervals throughout the year. Observations of deep earth temperatures were made in Pennsylvania, Wyoming, and Oregon. A paper on "Apparatus for the measurement of temperatures in deep wells by means of maximum thermometers" is ready for publication. A patent has been granted on one of the machines used in measuring the depths to which thermometers are lowered into deep wells. Two papers dealing with the subject of isostasy were completed. The first, "Notes on isostasy," was published in the Bulletin of the Geological Society of America as an appendix to the paper by W. T. Lee on "Building of the southern Rocky Mountains." A second paper, "Some phases of the resistance of the earth's material to changes," was prepared as a contribution to the general subject of mountain building on the basis of isostatic adjustment.

A. F. Melcher continued the general study of the texture of oil and gas sands in various parts of the United States. With the assistance of M. A. Shoultes and of J. G. Douglas, a student of Johns Hopkins University, he completed determinations of the pore space of 200 samples of oil and gas sands. Mr. Shoultes also assisted in the determination of the diameter of grains of 40 samples. In connection with this work a special study is being made of the Hickman sand in the Burbank field, Okla., with the object of ascertaining the variations in diameter of the grain in different parts of the field, and also of establishing a relation between porosity and initial production. A report on the texture of oil and gas sands with relation to production is nearly completed. K. C. Heald cooperated in some of the field work. In addition to assisting in the experimental and computational work of the laboratory Mr. Shoultes conducted heating tests of oil shales and of solids in process of diffusion.

A number of papers prepared for publication, both official and for private journals, were reviewed by various members of the division.

ALASKAN MINERAL RESOURCES BRANCH.

The personnel of the Alaska force included, on July 1, 1922, 1 chief Alaskan geologist, 4 geologists, 2 topographers, 1 draftsman, and 3 clerks on annual salaries, 1 geologist on monthly salary, and 1 geologist and 2 geologic aids on per diem salaries; and on June 30, 1923, 1 chief Alaskan geologist, 6 geologists, 2 topographers, 1 cadastral engineer, 1 draftsman, and 4 clerks on annual salaries, 1 assistant geologist and 1 junior topographer on monthly salaries, and 2 geologists, 1 assistant geologist, and 1 geologic aid on per diem salaries.

The Alaska field season extends from May to October, and the subsequent office work required to complete the results of field investigations usually extends to the beginning of the next field season. The period covered therefore does not coincide with the fiscal year, but as appropriations for work on Alaska are made available immediately, field work may be done until the end of a fiscal year on two appropriations simultaneously. In a region so remote as Alaska, however, and in projects that do not conform to the fiscal period, it is necessary to report by projects, not by periods. The accompanying statement therefore shows the work done during the field season of 1922, as defined above, and gives such notes on the projects for the field season of 1923 as were available at the time the report was prepared.

A reconnaissance topographic and geologic survey of the oil fields of Alaska Peninsula was made by a double party in charge of R. H. Sargent. Mr. Sargent was accompanied by W. R. Smith, geologist. The second party in this general region was under the leadership of R. K. Lynt, accompanied by A. A. Baker, geologist.

C. Arthur Hollick was employed for seven months in continuing his studies of the Alaska Tertiary fossil plants.

James McCormick was employed for six months in the revision of the "Geographic dictionary of Alaska." John B. Torbert was engaged in Alaska cartographic work throughout the year, and E. B. Hill, assistant topographic engineer, was engaged in work on Alaska maps for about two months.

Miss Lucy M. Graves, chief clerk, has continued to carry much of the clerical administration of the branch and has acted as chief during the absence of the chief and acting chief Alaskan geologists. The details of collecting statistics of the mineral production of Alaska have been in the hands of T. R. Burch.

Field season of 1923.—Alfred H. Brooks left Washington June 21, 1923, to make certain inquiries in Seattle and carry on some investigations in the vicinity of Juneau, Alaska.

A. F. Buddington is continuing a geologic reconnaissance survey and study of the mineral resources of the Wrangell district.

S. R. Capps, on furlough since April 16, 1922, returned May 1, 1923, and resumed the preparation of his report on the geology and mineral resources of the region tributary to the Alaska Railroad. In June, 1923, he took over administrative charge of the branch as acting chief Alaskan geologist. In the later part of the summer he will continue the investigation of the geology and mineral resources of the country along the Alaska Railroad.

G. C. Martin, after a comparative study of some of the oil districts in California, is making geologic and petroleum investigations in the Alaska Peninsula.

J. B. Mertie, jr., is extending the geologic reconnaissance survey and study of the mineral resources of the Chandalar district and adjacent regions of Alaska.

F. H. Moffit is making geologic surveys and investigating the copper deposits of Prince William Sound region.

Sidney Paige, in charge of three combined geologic and topographic parties, is surveying Naval Petroleum Reserve No. 4, on the Arctic coast of Alaska. The scientific personnel of his party comprises Wm. T. Foran and James Gilluly, geologists; E. C. Guerlin, cadastral engineer; and Gerald FitzGerald, topographer.

R. K. Lynt, accompanied by W. R. Smith, geologist, is extending geologic and topographic surveys in the Cold Bay region.

R. H. Sargent, accompanied by K. F. Mather, geologist, is making a geologic and topographic reconnaissance survey of the Douglas River-Katmai region.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch during the year was as follows:

Chief topographic engineer, C. H. Birdseye.

Atlantic division, topographic engineer in charge, Frank Sutton.

Central division, topographic engineer in charge, W. H. Herron.

Rocky Mountain division, topographic engineer in charge, Glenn S. Smith. (In the absence of Mr. Birdseye Mr. Smith acted as chief topographic engineer.)

Pacific division, topographic engineer in charge, T. G. Gerdine.

Division of West Indian surveys, topographic engineer in charge, Glenn S. Smith.

Computing section, topographic engineer in charge, E. M. Douglas.

Section of inspection and editing, topographic engineer in charge, W. M. Beaman.¹

¹ Mr. Beaman was on duty with the Brazilian Centennial Exposition at Rio de Janeiro from August 16, 1922, to May 31, 1923, and during that time L. S. Leopold was in charge of the section.

Section of cartography, draftsman in charge, A. F. Hassan.

Map information office, topographic engineer in charge, J. H. Wheat.

Section of relief maps, geographer in charge, J. H. Renshaw.

Section of photographic mapping, topographic engineer in charge, T. P. Pendleton.*

PERSONNEL.

The technical force was increased by the appointment of 10 junior topographers, 1 phototopographic engineer, 4 draftsmen, 1 temporary computer, and 4 temporary draftsmen and the reinstatement and transfer of 1 topographic engineer, 4 assistant topographic engineers, 2 junior topographers, and 3 draftsmen. The force was reduced by 1 death, 9 resignations, and 5 transfers. With these changes the corps now includes 1 chief topographic engineer, 4 topographic engineers in charge of divisions, 4 geographers, 75 topographic engineers, 2 topographers, 41 assistant topographic engineers, 30 junior topographers, 1 phototopographic engineer, 1 map editor, 2 map revisers, 1 computer, and 14 draftsmen, a total of 176. During the year 12 topographic engineers, 3 assistant topographic engineers, and 6 junior topographers were on furlough. In addition, 21 technical field assistants were employed during the whole or a part of the year. The clerical force comprises 12 clerks of various grades, one of whom is a temporary employee.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consisted of 71 new standard topographic maps, 9 new State maps, and 42 river plans and profiles; 2 State maps completely revised are in press. Advance photolithographic editions were printed for 95 new topographic maps now in process of engraving and final publication, and 68 photolithographs were printed of new topographic maps, for which publication has not yet been otherwise provided. Additional publications were a shaded relief map of Ohio; maps of the Lafayette National Park, Maine, and the Jephtha Knob area, Kentucky; and a road map of Washington, D. C., and vicinity.

The remaining advance chapters of Bulletin 709, giving results of triangulation and primary traverse for 1916-1918, prepared for publication in 1920, were published during the year.

Manuscript for a bulletin giving level results in California for 1896-1922 has been transmitted for publication.

APPROPRIATIONS.

The Federal appropriations for topographic surveys for the fiscal year 1923 were as follows:

Topographic surveys	\$325,000.00
Salaries, scientific assistants	9,200.00
Special funds for military mapping (contributed by War Department)	34,629.11
	<hr/> 368,829.11

* Mr. Pendleton was on leave without pay from the beginning of the fiscal year to May 1, 1923, and during that time J. H. Wheat was in charge of the section.

COOPERATION.

Cooperation has been maintained in 22 States and 1 Territory, which contributed the following amounts:

California -----	\$46,851.80	Pennsylvania -----	\$26,973.84
Connecticut -----	1,728.81	South Dakota -----	5,033.50
Hawaii -----	22,328.11	Tennessee -----	3,606.27
Idaho -----	174.27	Texas -----	15,545.21
Illinois -----	27,832.47	Utah -----	8,934.90
Iowa -----	1,985.67	Vermont -----	2,999.79
Kentucky -----	17,082.95	Virginia -----	2,850.18
Louisiana -----	14,518.42	Washington -----	7,582.82
Maine -----	6,692.28	West Virginia -----	20,093.64
Mississippi -----	5,446.43	Wisconsin -----	14,194.51
Missouri -----	15,823.36		
New York -----	14,400.92		286,302.44
Oregon -----	3,527.29		

In addition, work was executed as follows: Base-map work for the land-classification branch, cost, \$7,500; work for the Reclamation Service, \$5,914.06; base-map work for the Coal Commission, \$4,285.86; base-map work for the Forest Service, \$2,026.95; work for the Bureau of Immigration, \$19.33; work for the International Boundary Commission, \$5.20; work for the National Park Service, \$2,856; field surveys for the Navy Department, \$544.07; work for the Office of Public Buildings and Grounds, \$19.20; base-map work for the Bureau of Education, \$126.16. The total amount available from these sources was \$23,296.83.

The total amount expended from all sources for the work of the topographic branch was \$678,428.38.

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1923, distinguished as to scale and date, is shown on Plate I.

As shown in the following table, the new area mapped was 13,129 square miles, making the total area surveyed to date in the continental United States, exclusive of Alaska, 1,232,041 square miles, or 40.7 per cent of the entire country. In addition, 1,710 square miles of resurvey was completed, making the total area of surveys during the year 14,839 square miles. River surveys amounting to 564 linear miles were also made.

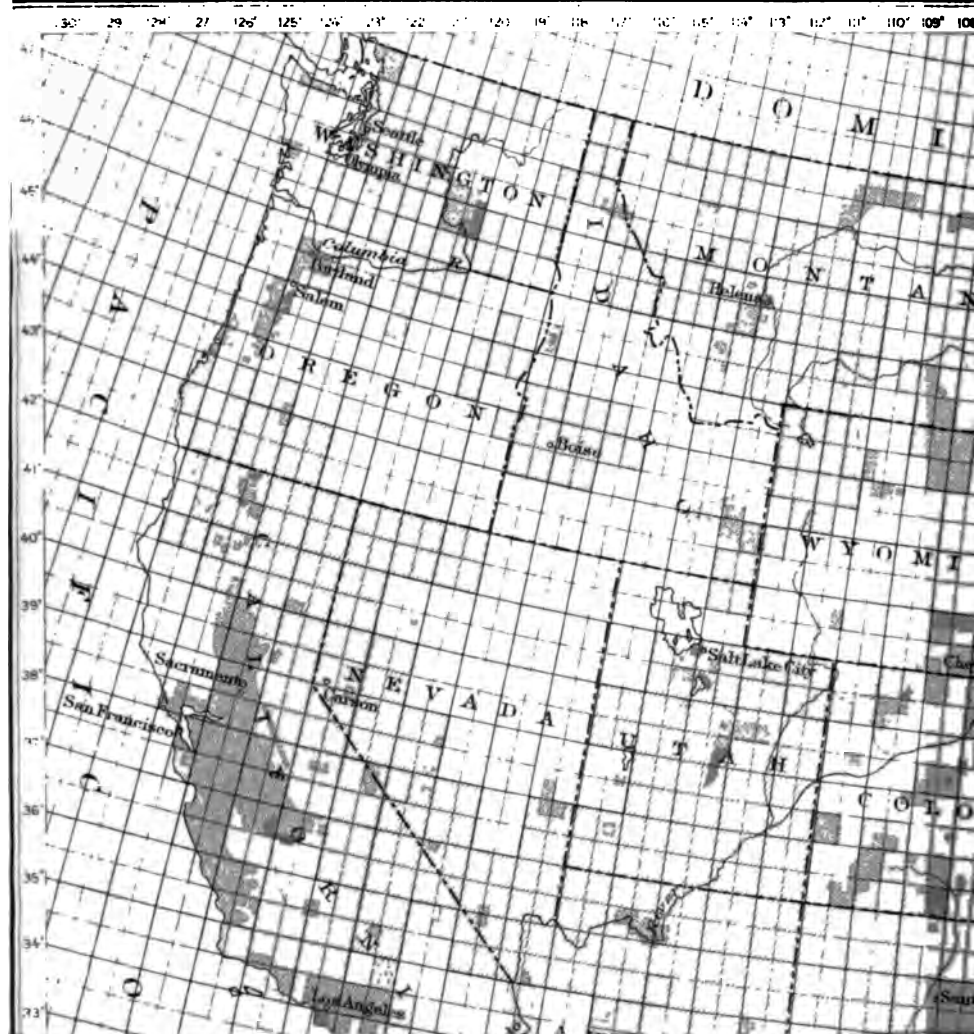
In connection with these surveys 6,413 linear miles of primary levels were run, making 297,194 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,733 permanent bench marks were established.

Triangulation stations to the number of 102 were occupied and 83 were permanently marked.

Primary traverse lines aggregating 2,314 miles were run, in connection with which 484 permanent marks were set.

In addition, 559 square miles of topographic mapping was completed in Hawaii and 65 miles of primary levels were run and 21 bench marks established.

U. S. GEOLOGICAL SURVEY



Present condition of topographic surveys of the United States and new area surveyed July 1, 1922, to June 30, 1923.

State.	New area mapped July 1, 1922, to June 30, 1923.	Total area mapped to June 30, 1923.	Percentage of total area of State mapped to June 30, 1923.	State.	New area mapped July 1, 1922, to June 30, 1923.	Total area mapped to June 30, 1923.	Percentage of total area of State mapped to June 30, 1923.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>			<i>Sq. miles.</i>	<i>Sq. miles.</i>	
Alabama.....		19,192	37.0	New Jersey.....		8,224	100.0
Arizona.....		55,429	48.7	New Mexico.....		40,412	32.9
Arkansas.....		21,494	40.3	New York.....	1,094	47,828	97.2
California.....	1,012	121,074	76.5	North Carolina.....		18,876	36.0
Colorado.....	224	51,358	49.4	North Dakota.....		10,017	14.1
Connecticut.....		4,965	100.0	Ohio.....		41,040	100.0
Delaware.....		2,370	100.0	Oklahoma.....		39,908	57.0
District of Columbia.....		70	100.0	Oregon.....	351	26,255	27.2
Florida.....		4,716	8.0	Pennsylvania.....	1,898	30,825	68.3
Georgia.....		24,835	41.9	Rhode Island.....		1,248	100.0
Idaho.....	14	28,586	33.9	South Carolina.....		13,675	44.1
Illinois.....	1,886	22,300	39.4	South Dakota.....	134	19,243	24.8
Indiana.....	18	3,627	10.0	Tennessee.....	132	21,552	51.3
Iowa.....	109	12,495	22.3	Texas.....	1,028	78,341	20.5
Kansas.....		6,159	78.0	Utah.....	553	16,855	19.8
Kentucky.....	696	19,893	48.9	Vermont.....	410	5,700	59.6
Louisiana.....	444	8,810	18.2	Virginia.....	240	36,512	85.7
Maine.....	291	11,135	33.7	Washington.....	715	32,719	47.3
Maryland.....		12,327	100.0	West Virginia.....		24,170	100.0
Massachusetts.....		8,266	100.0	Wisconsin.....	562	15,168	27.1
Michigan.....		11,153	19.2	Wyoming.....		30,088	30.7
Minnesota.....		7,354	8.7				
Mississippi.....	119	3,881	8.3	Total continental United States (exclusive of Alaska).....			
Missouri.....	1,199	39,813	57.3				
Montana.....		41,590	28.5				
Nebraska.....		27,117	35.0				
Nevada.....		41,141	37.5	Hawaii.....	13,129	1,232,041	40.7
New Hampshire.....		4,235	45.3		559	2,975	46.1

Topographic surveys from July 1, 1922, to June 30, 1923.

State.	Contour interval.	For publication on scale of—				Total area surveyed.		
		1:20,000.	1:24,000.	1:31,680.	1:62,500.	New.	Resurvey.	Total.
	<i>Fert.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
California.....	5		402	610		1,012		1,012
Colorado.....	20, 50			94	130	224		224
Idaho.....	50				14	14		14
Illinois.....	10, 20				1,886	1,886		1,886
Indiana.....	10				18	18		18
Iowa.....	20				109	109		109
Kentucky.....	20				696	696		696
Louisiana.....	20				444	444		444
Maine.....	20				291	291		291
Massachusetts.....	10	46					46	46
Mississippi.....	5, 10, 20		61		58	119		119
Missouri.....	10, 20		163		1,035	1,199		1,199
New York.....	20				1,094	1,094		1,094
Oregon.....	5, 20, 25, 50			130	221	351		351
Pennsylvania.....	20				1,898	1,898		1,898
South Dakota.....	20				134	134		134
Tennessee.....	20				132	132		132
Texas.....	5, 20		76		952	1,028		1,028
Utah.....	1, 5, 50		187	366		553		553
Vermont.....	20				410	410		410
Virginia.....	20				240	240		240
Washington.....	25				715	715		715
West Virginia.....	50				1,664		1,664	1,664
Wisconsin.....	20				562	562		562
Hawaii.....	10, 50	46	889	1,200	12,704	13,129	1,710	14,839
				559		559		559

Topographic surveys from July 1, 1922, to June 30, 1923—Continued.

State.	Levels.		Primary traverse.		Triangulation.	
	Distance run.	Permanent bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	<i>Miles.</i>		<i>Miles.</i>			
California.....	457	103	115	18	51	24
Connecticut.....	488	150				
Idaho.....					15	15
Illinois.....	779	221	325	68		
Iowa.....			173	34		
Kentucky.....	329	80	258	71		
Louisiana.....	746	217	479	134		
Maine.....	183	42				
Massachusetts.....	134	24	125	29		
Mississippi.....	153	45				
Missouri.....	245	75	120			
New York.....	311	67	274	42		
Ohio.....			160	13		
Oregon.....		8				
Pennsylvania.....	274	96				
Rhode Island.....	8					
South Dakota.....	386	125				
Tennessee.....	287	64				
Texas.....	529	131	201	54		
Utah.....	368	74			26	26
Vermont.....	158	43			2	3
Virginia.....	81	27				
Washington.....	200	54			8	6
West Virginia.....	69	13				
Wisconsin.....	228	74	84	21		
Hawaii.....	6,413 65	1,733 21	2,314	484	102	88

GENERAL OFFICE WORK.

Computations for vertical and horizontal control were made and the results were copied and catalogued by the computing section. The section of relief maps prepared shaded relief maps of Colorado and West Virginia; Grand Canyon of Colorado River; Asheville and vicinity and Brown Mountain district, N. C.; Teapot Dome, Wyo.; and parts of Pennsylvania, northern New Mexico, and the San Juan Mountains, Colo., as well as of the following quadrangles: Altoona, Milton, Tyrone, and Philipsburg, Pa., and Clintonville, Hanging Rock, Ronceverte, and White Sulphur Springs, W. Va. The section of photographic mapping was engaged in miscellaneous work in connection with the utilization of Air Service photographs in topographic mapping. The map-information office was engaged in indexing and cataloguing the map data available in the several Federal departments and a number of non-Federal organizations and in furnishing miscellaneous map information to the public.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

The section of inspection and editing of topographic maps continued to supervise the office preparation of all topographic maps and to inspect and edit them before reproduction; it also edited a number of maps submitted by other Survey branches and Government bureaus.

The number of Survey topographic maps in progress in the topographic branch (exclusive of those being engraved and printed) ranged from 145 in August to 192 in January; the monthly average was 174.

An average of 14 employees were engaged in this section for the year.

W. M. Beaman was designated as the representative of the topographic branch of the Survey at the exhibit of military maps and mapping held jointly with the Corps of Engineers and the Military Intelligence Division, United States Army, at the Brazilian Centennial Exposition in Rio de Janeiro. While on this duty Mr. Beaman was furloughed without pay from the Survey from August 16 to May 31 and reported to the Brazilian Centennial Commission. During his absence L. S. Leopold was acting chief of the section.

James McCormick divided his time between representing the Survey on the United States Geographic Board and on similar special investigations and a revision of the "Geographic dictionary of Alaska."

The work of this section is described further under "Publication branch" (p. 82).

SECTION OF CARTOGRAPHY.

The compilation of the base of the United States portion of the international map of the world was continued during the year with the cooperation of the Bureau of Public Roads. The Texas portion of this map, in course of compilation the previous year, was completed, and the Arizona and Oregon portions were completely revised, as was the Montana portion, which was partly revised the previous year. Maps of this series have been prepared for 47 States.

Other map projects included the preparation for the Air Service, United States Army, of an air-navigation map of central California and strip maps of the territory from Dayton, Ohio, to Wheeling, W. Va., and from Wheeling, W. Va., to Washington, D. C. Other strip maps for air navigation were in course of preparation; a map of Fayette County, Tenn., was redrafted for the State; the road map of Illinois was revised for the State; and several graphs and charts were prepared for the Federal Board for Vocational Education. One employee was detailed in charge of drafting for the Coal Commission, and another was engaged for a short period in map work for Porto Rico.

ATLANTIC DIVISION.

FIELD WORK.

Connecticut.—In cooperation with the Connecticut State Highway Commission for control of new work, 488 miles of primary levels were run and 150 permanent bench marks established. In addition, the United States Coast and Geodetic Survey ran 278 miles of precise levels and set 241 permanent bench marks, the work being paid for by the Geological Survey.

Maine.—In cooperation with the Maine State Water Power Commission, the survey of the Long Pond quadrangle was completed, and that of the Burnham quadrangle was begun.

Massachusetts.—The resurvey of Camp Devens and vicinity was begun, the total area mapped being 46 square miles, for publication on the scale of

1:20,000, with a contour interval of 10 feet. For the control of this area 134 miles of primary levels were run, 24 permanent bench marks established, 125 miles of primary traverse run, and 29 permanent marks set. This work was done for the War Department.

New York.—In cooperation with the State engineer of New York, the survey of the Andes, Ellicottville, Randolph, and Walton quadrangles was completed, and that of the Chafee, Colden, and Franklinville quadrangles was begun. At the request of the Bureau of Yards and Docks, Navy Department, the survey of a proposed hospital site for the Veterans' Bureau near Liberty, N. Y., was completed. The cost of the work was paid by the Navy Department.

Pennsylvania.—In cooperation with the Pennsylvania State Bureau of Topographic and Geological Survey, the survey of the Mauch Chunk, Milton, Mount Union, Oil City, Reynoldsville, Stoddartsville, and Tionesta quadrangles was completed, and that of the Berlin, Brookville, Cambridge Springs, Meadville, and Towanda quadrangles was begun.

Pennsylvania-New Jersey.—In cooperation with the Pennsylvania State Bureau of Topographic and Geological Survey, the survey of the Bushkill quadrangle was begun. The area mapped was all in Pennsylvania.

Rhode Island.—For the control of Block Island 8 miles of primary levels were run. This work was done for the War Department.

Tennessee.—At the request of the Engineer Corps of the Army, 202 miles of primary levels were run along Tennessee River and 56 permanent bench marks were set, to be used by the Corps in the investigation of the Tennessee River basin.

Tennessee-Kentucky.—In cooperation with the Tennessee State geologist, the survey of the Lillydale quadrangle was completed and that of the Byrdstown quadrangle was begun. The area mapped was all in Tennessee.

Vermont.—In cooperation with the Vermont State geologist, the survey of the Barre quadrangle was completed and that of the Corinth quadrangle was begun. In addition, the survey of the Franklin Pond quadrangle was completed and that of the Irasburg and Montgomery quadrangles was begun. This work was done for the War Department.

Virginia.—In cooperation with the State geologist of Virginia, the survey of the Callands quadrangle was completed.

Virginia-North Carolina.—In cooperation with the State geologist of Virginia, the survey of the Danville quadrangle was begun. The area mapped was all in Virginia.

West Virginia.—In cooperation with the State geologist of West Virginia, the resurvey of the Durbin, Horton, Lobelia, Marlinton, and Mingo quadrangles was completed.

West Virginia-Virginia.—In cooperation with the State geologist of West Virginia, the resurvey of the Cass, Hightown, Spruce Knob, and Warm Springs quadrangles was completed. The area mapped was all in West Virginia.

OFFICE WORK.

The drafting of 22 sheets was completed, and that of 9 sheets was begun. Primary-level circuits were adjusted for 26 quadrangles. Geographic positions were computed for 22 quadrangles.

CENTRAL DIVISION.

FIELD WORK.

Illinois.—In cooperation with the Illinois Department of Registration and Education, the survey of the Essex, Geneva, Glenarm, Kankakee, Liberty, Oregon, and Taylorville quadrangles was completed and that of the Assumption, Cornland, Elgin, Harvel, Marion, Morrisonville, Petersburg, and Yorkville quadrangles was begun. In addition, the survey of projects Nos. 4, 5, 12, 13, 14, and 15 was completed, the total area mapped being 317 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. This work was done in such a manner as to be available for future incorporation in regular topographic maps.

Illinois-Indiana.—In cooperation with the State of Illinois, the survey of the Momence quadrangle was completed.

Iowa.—In cooperation with the Iowa State Geological Survey, the survey of the Melcher quadrangle was completed.

Kentucky.—In cooperation with the Kentucky Geological Survey, the survey of the Frankfort, Mammoth Cave, and Leitchfield quadrangles was completed and that of the Cub Run, Horse Branch, and Waddy quadrangles was begun.

Missouri.—In cooperation with the Missouri State geologist the survey of the Cape Girardeau, Perryville, Polo, and Winston quadrangles was completed and that of the Ford City, Glilan City, Maysville, Pattonsburg, and Plattsburg quadrangles was begun. In addition a survey was made along certain highway routes in Linn, Macon, and Livingston counties, 163 square miles being completed on the scale of 1:24,000, with a contour interval of 10 feet. This work was done in such a manner as to be available for future incorporation in regular topographic maps. A plan and profile survey was made of Gasconade River from Arlington to Rich Fountain, the sketching extending to the top of the bluffs along the river and up all tributaries 100 feet above the elevation of the river for a distance of 53 miles from the initial point. In connection with this project 36 miles of levels were run and 14 bench marks established.

Missouri-Illinois.—In cooperation with the State of Missouri the survey of the Altenburg quadrangle was completed and that of the Alton and Bonfile quadrangles was begun. The area mapped was all in Missouri.

Ohio.—In preparation for the revision of the maps of the East and West Columbus quadrangles 160 miles of primary traverse were run and 13 permanent marks set.

Wisconsin.—In cooperation with the State geologist of Wisconsin the survey of the Black River Falls, Galesville, La Farge, North Bend, Pigeon Falls, and Viroqua quadrangles was begun. In addition the survey of highway projects Nos. A, and B, was completed and that of highway projects Nos. C, C₁, and D, was begun. This work was arranged in such a manner as to be incorporated without adjustment into regular maps of quadrangles of which the areas surveyed are a part.

OFFICE WORK.

The drafting of 26 sheets was completed and that of 16 sheets was begun. Primary-level circuits were adjusted for 41 quadrangles. Geographic positions were computed for 66 quadrangles.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Colorado.—The survey of the Elkhead No. 3 quadrangle was begun.

Colorado-Utah.—The Geological Survey made special surveys and investigations to ascertain the feasibility of storing and diverting the waters of Green River for irrigation and for the generation of power. These surveys extended from Green River, Wyo., to Green River, Utah. In this connection surveys were made of Yampa River from its mouth to Cross Mountain reservoir site. In this work 306 miles of river traverse and 94 square miles of topographic mapping (67 square miles along Green River and 27 square miles along Yampa River) were completed, for publication on the scale of 1:31,680, with a contour interval of 20 feet. This work was done for the land-classification branch and in cooperation with the Utah Power & Light Co.

Idaho.—In cooperation with the Forest Service triangulation was extended over the Idaho National Forest, 15 stations being occupied and 15 marked.

Idaho-Oregon.—In cooperation with the State Bureau of Mines and Geology of Idaho and the State Bureau of Mines and Geology of Oregon, the survey of the He Devil quadrangle was continued.

Louisiana.—In cooperation with the Department of Conservation of Louisiana, the survey of the Sarepta quadrangle was completed and that of the Bossier and Plain Dealing quadrangles was begun.

Mississippi.—In cooperation with the Mississippi Geological Survey, the survey of the Pelahatchee quadrangle was completed. In addition, a plan and profile survey of Pearl and Strong rivers was made to ascertain the feasibility of water-power development. In connection with this work 17 miles of river traverse and 61 square miles of topographic mapping were completed, for publication on the scale of 1:24,000, with contour intervals of 5, 10, and 20 feet. For the control of this area 153 miles of primary levels were run and 45 permanent bench marks were established. At the request of the Bureau of Yards and Docks, Navy Department, a proposed hospital site for the

Veterans' Bureau near Gulfport, Miss., was surveyed. The cost of the work was paid by the Navy Department.

South Dakota.—In cooperation with the State geologist of South Dakota, the survey of the Pierre quadrangle was completed.

Texas.—In cooperation with the Texas Bureau of Economic Geology and Technology, the survey of the Aransas Pass, Corpus Christi, Driscoll, Oso Creek, and Robstown quadrangles was completed. In cooperation with the State Board of Water Engineers, the survey of the Breckenridge reservoir site, the Bronte reservoir site, and the Fort Worth reservoir site was completed.

Utah.—In cooperation with Box Elder, Salt Lake, Tooele, Utah, and Weber counties, Utah, and the United States Reclamation Service, the survey of these counties was begun, the total area mapped being 187 square miles. For the control of these projects 368 miles of primary levels were run, 74 permanent bench marks established, and 26 triangulation stations occupied, 25 of which were permanently marked. This work was done to aid in planning irrigation and drainage systems, and the results will be incorporated in regular topographic maps. In addition, the survey of the Hlawaatha quadrangle was completed, that of the Castle Dale and Monument Peak quadrangles was continued, and that of the Emery quadrangle was begun, the total area mapped being 366 square miles, for publication on the scale of 1:31,680, with a contour interval of 50 feet. This work was done for the land-classification branch.

OFFICE WORK.

The drafting of 12 sheets was completed and that of 8 sheets was begun. Primary-level circuits were adjusted for 41 quadrangles. Geographic positions were computed for 26 quadrangles.

PACIFIC DIVISION.

FIELD WORK.

California.—In cooperation with the California Department of Public Works, for work in San Joaquin Valley, the survey of the Caruthers, Conejo, Gravel Ford, Helm, Jameson, Raisin, San Joaquin, Selma, and Tranquillity quadrangles was completed and that of the Laton and Riverdale quadrangles was begun. In cooperation with the United States Reclamation Service, the Klamath-Shasta Valley irrigation district, and the Department of Public Works of California, the survey of the Shasta Valley project was completed on a scale of 1:24,000, with a contour interval of 5 feet, for preliminary study and planning the general outline of an irrigation system. In connection with this project 160 square miles of topographic mapping was completed. For the control of this area, 15 miles of primary levels were run and 3 permanent bench marks established. In cooperation with Los Angeles County the survey of the Compton, Florence, Inglewood, Sawtelle, Torrance, and Venice 6-minute quadrangles was completed and that of the Van Nuys and Wilmington 6-minute quadrangles was begun, the total area mapped being 242 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. Practically all the expenses for this work were paid by Los Angeles County. Airplane photographs were taken by the Army Air Service, which aided in the progress of mapping wooded and marshy areas. For the control of this work 302 miles of primary levels were run, 67 permanent bench marks established, 78 miles of primary traverse run, 8 permanent marks set, and 51 triangulation stations occupied, 34 of which were marked.

Hawaii.—In cooperation with the governor of Hawaii, the survey of the Kahului NE. $\frac{1}{4}$, Kahului SE. $\frac{1}{4}$, Kahului SW. $\frac{1}{4}$, Kalapana NW. $\frac{1}{4}$, Kalapana NE. $\frac{1}{4}$, Kalapana SW. $\frac{1}{4}$, Lahaina NW. $\frac{1}{4}$, Lahaina NE. $\frac{1}{4}$, Lahaina SW. $\frac{1}{4}$, Lahaina SE. $\frac{1}{4}$, Makuu NW. $\frac{1}{4}$, Makuu SE. $\frac{1}{4}$, Makuu SW. $\frac{1}{4}$, Puna NE. $\frac{1}{4}$, and Puna SE. $\frac{1}{4}$ quadrangles was completed and that of the Puako SE. $\frac{1}{4}$ quadrangle was begun.

Oregon.—In cooperation with the State engineer, the survey of the Lebanon quadrangle was completed, that of the Airlie quadrangle was continued, and that of the Aumsville quadrangle was begun. In addition, a plan and profile survey of Rogue River and its tributaries, covering 188 linear miles of river, was made, the total area mapped being 122 square miles, for publication on the scale of 1:31,680, with contour intervals of 5 and 20 feet. In connection

with this work several dam sites were surveyed. This work was done for the land-classification branch and in cooperation with the California Oregon Power Co.

Washington.—In cooperation with the Washington State Department of Conservation and Development, the survey of the Hanford, Othello, and Scooteney Lake quadrangles was completed and that of the Hicksville quadrangle was begun.

OFFICE WORK.

The drafting of 35 sheets was completed and that of 5 sheets was begun. Primary-level circuits were adjusted for 5 quadrangles. Geographic positions were computed for 22 quadrangles.

DIVISION OF WEST INDIAN SURVEYS.

The Geological Survey has continued to supervise topographic work in the Republic of Haiti and in Porto Rico. This work comprised the completion of the compilation from airplane photographs of fifteen 30-minute sheets, showing the coast line and the interior rivers of the Republic of Haiti on the scale of 1:100,000 and a general map of the Republic of Haiti on the scale of 1:400,000. The drawing of publication sheets of the Isabela irrigation district of Porto Rico was also completed.

WATER-RESOURCES BRANCH.

ORGANIZATION.

The work of the water-resources branch was conducted under the supervision of N. C. Grover, chief hydraulic engineer, and is organized in five divisions:

Division of surface water, John C. Hoyt, hydraulic engineer, in charge.

Division of ground water, O. E. Meinzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

Division of enlarged and stock-raising homesteads, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL.

During the year the technical force was reduced 21 and was increased 18—a net reduction of 3. At the end of the year the force consisted of 1 chief hydraulic engineer, 32 hydraulic engineers, 6 engineers, 29 assistant engineers, 19 junior engineers, 4 geologists, 2 assistant geologists, 1 chemist, 3 associate chemists, 9 classifiers, and 1 expert mechanician, a total of 107. Of this number 2 hydraulic engineers, 1 engineer, 3 assistant engineers, 4 junior engineers, and 1 expert mechanician are employed occasionally. In addition 13 members of the advisory board of the superpower survey hold appointments for occasional service in the study of problems relating to interconnection of power systems, especially those crossing State boundaries.

In the clerical force there were 4 separations and 3 accessions, and at the end of the year the force numbered 33. Of this number 7 are employed occasionally.

ALLOTMENTS.

The appropriation for gaging streams was \$180,000. In addition \$67,869.44 of the appropriation for classification of lands was expended for field work by the water-resources branch. Of the total

appropriations, 81 per cent was allotted for work in public-land States. The cooperative funds made available by State allotments, amounting to \$216,228.76, have been increased in some States and decreased in others, making necessary corresponding adjustments of this work.

Allotments of appropriation for gaging streams, 1922-23.

Administration, general.....	\$18,921.12	Surface water—Continued.	
Branch administration.....	10,000.00	Missouri.....	\$4,000.00
Computations.....	15,000.00	Kansas.....	3,500.00
Inspection.....	1,400.00	Colorado, Wyoming,	
		and New Mexico.....	7,500.00
	<u>45,321.12</u>	Montana.....	5,000.00
Surface water:		North Dakota.....	300.00
Connecticut.....	500.00	Utah.....	5,000.00
Maine.....	1,000.00	Nevada.....	3,000.00
New Hampshire.....	1,500.00	Idaho.....	5,000.00
Vermont.....	1,000.00	Oregon.....	5,000.00
Massachusetts.....	2,500.00	Washington.....	5,000.00
New York.....	5,500.00	California.....	5,500.00
New Jersey.....	3,000.00	Arizona.....	3,500.00
Middle Atlantic States.....	3,000.00	Hawaii.....	4,500.00
South Atlantic States.....	5,000.00		<u>98,100.00</u>
Tennessee and Kentucky.....	3,000.00	Ground water.....	13,500.00
Ohio.....	3,000.00	Quality of water.....	13,000.00
Texas.....	5,000.00	Power resources.....	8,500.00
Wisconsin.....	3,500.00	General supplies.....	500.00
Minnesota.....	300.00	Contingent.....	1,078.88
Iowa.....	2,000.00		<u>180,000.00</u>
Illinois.....	1,500.00		

COOPERATION.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional service in field and office.

Alabama.....		\$72.00
Arizona:		
Gaging streams.....	\$3,000.00	
Water resources.....	1,433.83	
Ground water, San Pedro Valley.....	2,600.00	
		<u>7,033.83</u>
California:		
State.....	23,206.20	
County and city.....	12,110.59	
		<u>35,316.79</u>
Colorado:		
State.....	1,300.00	
City.....	200.00	
		<u>1,500.00</u>
Connecticut.....		199.97
Georgia.....		240.00
Hawaii:		
Territorial.....	\$18,414.84	
City and county.....	1,530.00	
		<u>19,944.84</u>

Idaho:

State Department of Reclamation—

Outside of Snake River basin..... \$14,232.13

Snake River basin..... 2,676.56

Bureau of Mines and Geology..... 1,601.12

\$18,509.81

Illinois 3,862.06

Iowa 3,229.30

Kansas 4,004.27

Kentucky 424.65

Maine 4,232.92

Massachusetts 2,876.93

Minnesota 420.21

Missouri 8,879.31

Montana 9,965.81

New Hampshire 1,805.56

New Jersey 11,100.48

Nevada 2,009.85

New York:

State \$10,670.66

County and city..... 84.00

10,754.66

North Carolina 4,492.29

North Dakota 650.00

Ohio 6,000.00

Oregon 12,019.00

Tennessee 3,151.98

Texas:

State \$14,070.00

County and city..... 815.00

14,385.00

Utah 4,562.43

Vermont 1,199.99

Washington:

State \$6,216.76

County and city..... 5,285.00

11,501.76

West Virginia 486.00

Wisconsin 6,146.33

Wyoming 5,730.75

216,228.76

The work done under cooperative agreements with the States has been restricted to studies of stream flow, except in Arizona, California, Connecticut, Idaho, New Jersey, and North Dakota, where ground-water investigations have been made. (See pp. 65-67.)

Reclamation Service.—The measurements of streams that are to furnish water to reclamation projects under construction was continued in cooperation with the United States Reclamation Service. The field work was done by Survey engineers who were employed at the locality, and the cost was repaid by the Reclamation Service through transfer of funds.

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued on the Crow, Fort Hall, Yakima, Colville, Klamath, Gila River, Wind River, Minished, Western Shoshone, Walker River, and Uinta Indian reservations.

National Park Service.—Streams in the Yosemite, Yellowstone, and Glacier national parks were measured during the year at stations maintained in cooperation with the National Park Service.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service. Stream gaging in the Arapaho and Uncompahgre national forests was done by the Forest Service, which was reimbursed by the Geological Survey.

City of San Francisco.—In connection with the storage of the water of Tuolumne River in Hetch Hetchy Valley as a water supply for the city of San Francisco, measurement of that stream was continued in cooperation with the city government.

Federal Power Commission.—Projects of the Federal Power Commission in Utah, New Mexico, Idaho, and Colorado were examined. The operations of three licensees of the commission in California, two in Idaho, one in Oregon, one in Nevada, and one in Washington are supervised by the Geological Survey, as well as the operations of five permittees of the commission in Oregon, two in Idaho, one in Montana, one in Arizona, one in California, and one in Utah. All stream gaging by permittees of the commission is done in cooperation with the Geological Survey. Such cooperative stream gaging is in progress in Virginia, North Carolina, South Carolina, Florida, Alabama, Arkansas, Missouri, Montana, Iowa, Idaho, Wisconsin, Utah, Nevada, Colorado, Arizona, Washington, California, Oregon, and Texas.

PUBLICATIONS.

The publications of the year prepared by the water-resources branch comprised 17 reports and 2 separate chapters. Titles and brief summaries of these publications are given on pages 12-14. At the end of the year 20 other reports were in press and 11 manuscripts were awaiting editorial work.

DIVISION OF SURFACE WATER.

ORGANIZATION.

The work of the division of surface water consists primarily of the measurement of the flow of rivers, but it includes also special investigations of conditions affecting stream flow and the utilization of the streams. In carrying on the work the United States is divided into 23 districts, including Hawaii. The district offices and engineers in charge are as follows:

New England: C. H. Pierce, customhouse, Boston, Mass.
 New York: A. W. Harrington, Journal Building, Albany, N. Y.
 New Jersey: O. W. Hartwell, State House, Trenton, N. J.
 Middle Atlantic and Ohio River: A. H. Horton, Washington, D. C.
 South Atlantic and eastern Gulf: W. E. Hall, 33-35 Broadway, Asheville, N. C.
 Tennessee: W. R. King, Municipal Building, Chattanooga, Tenn.
 Ohio: Lasley Lee, Orton Hall, Ohio State University, Columbus, Ohio.
 Upper Mississippi River: S. B. Soule, Capitol Building, Madison, Wis.
 Illinois: H. E. Grosbach, Kimball Building, Chicago, Ill.
 Iowa: J. B. Spiegel, Engineering Hall, Iowa State College, Ames, Iowa.
 Kansas: H. B. Kinnison, Federal Building, Topeka, Kans.
 Missouri: H. C. Beckman, Rolla, Mo.
 Upper Missouri River: W. A. Lamb, Montana National Bank Building, Helena, Mont.

Rocky Mountain: Robert Follansbee, Post Office Building, Denver, Colo.
Great Basin: A. B. Purton, Federal Building, Salt Lake City, Utah.
Idaho: C. G. Paulsen, Idaho Building, Boise, Idaho.
Snake River basin: G. C. Baldwin, Federal Building, Idaho Falls, Idaho.
Washington: G. L. Parker, Federal Building, Tacoma, Wash.
Oregon: F. F. Henshaw, Post Office Building, Portland, Oreg.
California: H. D. McGlashan, customhouse, San Francisco, Calif., suboffice, Federal Building, Los Angeles, Calif.
Arizona: R. C. Rice, care of University of Arizona, Tucson, Ariz.
Texas: C. E. Ellsworth, Capitol Building, Austin, Tex.
Hawaii: E. D. Burchard, Capitol Building, Honolulu, Hawaii.

CHARACTER AND METHOD OF WORK.

Field investigations necessary to the work are made from the district offices, where the results are sufficiently analyzed to insure accuracy and completeness. At selected places, known as gaging stations, the volume of water carried by the streams is measured and records of stage and other data are collected from which the daily flow of the streams is computed. Data collected from the district offices are transmitted to Washington, where they are reviewed in the computing section and prepared for publication. By this review the records obtained in different parts of the country are brought to a uniform standard, and standardization is further effected through annual conferences of the engineers.

At the end of the year 1,591 gaging stations were being maintained, including 75 in Hawaii; 225 stations were discontinued and 276 new stations established during the year. Records for about 162 additional stations were received, ready for publication, from a number of Government bureaus and private persons, and a number of Government and State organizations and individuals also cooperated in the maintenance of the regular gaging stations.

Gaging stations and cooperating parties for the year ended June 30, 1923.

State or Territory.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Office.	Army engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gagings during year.	Miscellaneous gagings during year.
Alabama.....					2	1		1	2	5	2	9	2	3	54	5
Arizona.....		2		2		1		23	2	5	13	22	4	4	675	83
Arkansas.....										3		3	1		17	
California.....		21	1			1	6	214	44	91	164	214	32	11	1,941	615
Colorado.....	9	1	5			1		19	1	2	2	36	5	2	127	1
Connecticut.....	1									2		3			12	
Florida.....										1		1		1	7	
Georgia.....								4		8	1	13		1	11	
Idaho.....		6	7	14		2		97	1	188	81	234	126	128	1,684	281
Illinois.....					2	2		29	1	1	6	29	3	1	80	4
Indiana.....														2	1	
Iowa.....						6		23		6	7	28			130	
Kansas.....						3		31	1	9	13	31	1		178	6
Kentucky.....					6	1		6			7	6	3	2	29	1
Louisiana.....										3		3	2		78	
Maine.....								16		4	4	16			74	1
Maryland.....	3											3	2	2	6	1
Massachusetts.....								17				17			104	2
Michigan.....										1		1			1	
Minnesota.....				2	2			6				10			34	
Missouri.....					3			51		10	13	51	6		289	18
Montana.....	8	31	2	11			15	63		6	14	122	12	14	543	35
Nevada.....				3				29		12	15	29			166	14
New Hampshire.....								13		9	9	13	3		78	4
New Jersey.....						1		33	4	7	12	33	7		258	50
New Mexico.....		1													6	
New York.....								55	1	18	20	55	11	10	369	1
North Carolina.....				14				28		7	19	30	8	3	116	5
North Dakota.....								8				8			20	
Ohio.....					3	6		23	10	6	2	46	6	2	185	22
Oregon.....		1	1	6		3		81	31	26	60	89	10	13	576	10
South Carolina.....										1		1		1	2	
Tennessee.....					38	15		43		7	60	43	9	1	251	19
Texas.....						3		49	6	6	16	49		1	393	67
Utah.....		1		4				55	1	21	27	55	3	2	154	23
Vermont.....								12		7	7	12	3	2	58	1
Virginia.....	3				7	1				6	1	16	2		20	4
Washington.....			4	10			2	50	20	28	49	65	7	10	407	10
West Virginia.....					6			11		8	6	19	3		52	1
Wisconsin.....					3			40		8	11	40		3	193	10
Wyoming.....		7	1	6		1	6	41		11	13	60	6	3	215	5
Hawaii.....								74	3	29	31	75	1	3	423	52
	24	50	41	57	84	55	29	1,245	128	562	684	1,501	276	225	10,027	1,351

PUBLICATIONS.

For convenience and uniformity in publications the United States has been divided into 12 primary drainage basins, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions; the records for the twelfth division are published in three papers. In addition to the progress reports, special reports on hydraulic subjects have been completed for publication during the year.

DIVISION OF GROUND WATER.**GENERAL FEATURES.**

The division of ground water investigates the waters that lie below the surface—their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and at watering places for livestock and desert travelers. Each year surveys

are made of selected areas where the problems of water supply are most urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to quality of water are made in cooperation with the division of quality of water; the surveys in the Atlantic Coastal Plain are made by the geologic branch. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the United States Government, especially by the War and Navy departments. The ground-water division is called upon to furnish information and advice on a large number of these projects.

One of the most important new activities of the division during the year was the establishment of a small hydrologic laboratory to determine the mechanical composition, porosity, moisture equivalent, and permeability of water-bearing materials. This laboratory will be in charge of Norah E. Dowell. Another important project, undertaken in cooperation with the Department of Conservation and Development of New Jersey, is an intensive investigation of the ground-water supplies in that State for municipal and industrial purposes. This investigation was placed in charge of D. G. Thompson, but only preliminary work was done on it before the end of the fiscal year.

Kirk Bryan was assigned as geologist for the investigation of the Columbia Basin project by the Reclamation Service. He began field work on this project April 16, 1923.

G. E. P. Smith, irrigation engineer of the Arizona Agricultural Experiment Station, spent about four months in the Washington office on cooperative work and presented a paper before the Geological Society of Washington on his investigation of the discharge of ground water by vegetation, based on daily fluctuations of the water table.

Progress was made by O. E. Meinzer on his work on "Ground water in the United States, with a discussion of principles." At the end of the year Part I, which relates to the occurrence of ground water, was in galley proof, and Part II, which relates to the origin, discharge, and quantity of ground water, was nearly half completed. A brief paper entitled "Investigations of ground water in the western part of the United States" was prepared by Mr. Meinzer for use in the Pan-Pacific Scientific Congress, held in Australia in August and September, 1923. A brief paper on thermal springs in Nevada, Utah, and Idaho was presented by Mr. Meinzer at the meeting of the American Geophysical Union in Washington, D. C., April 18, 1923.

Cooperation with the committee on physiography was continued through Mr. Meinzer, who serves on that committee. Several manuscripts for geologic folios were examined with respect to their treatment on the subject of ground water.

WORK BY STATES.

Arizona.—A comprehensive report, entitled "The Papago country—a geographic, geologic, and hydrologic reconnaissance," was completed by Mr. Bryan for publication as a water-supply paper. Progress was made on a report on the geology and water resources of San Pedro Valley, by Mr. Bryan, of the Geological Survey, and Mr. Smith, of the Arizona Agricultural Experiment Station.

Arkansas.—Field and office studies of the temperature and source of the hot-water supply in the Hot Springs National Park were continued by Mr. Bryan.

California.—A comprehensive report, entitled "The Mohave Desert region—a geographic, geologic, and hydrologic reconnaissance," was virtually completed by D. G. Thompson for publication as a water-supply paper. Parts of this paper have already been made available to the public in the form of manuscript reports filed in the Los Angeles office of the Geological Survey. Ground-water maps of Salinas Valley and data in regard to irrigation wells in that valley were sent to the San Francisco office of the Geological Survey and to the county agent at Salinas, where they can be consulted by the public. These maps and data are based on field work done in previous years by W. O. Clark. The ground-water conditions in the Mariposa Grove of the Yosemite National Park were examined in June and July, 1922, by Mr. Bryan, who prepared a report for the National Park Service on an additional water supply for this part of the park. Water levels were measured in selected wells in southern California, as in previous years, under the direction of F. C. Ebert. The ground-water work in California was supported by financial cooperation of the State Department of Engineering.

Connecticut.—Additional field work was done in the Pomperaug Valley, Conn., by H. T. Stearns in May and June. All work in Connecticut is done in cooperation with the State Geological and Natural History Survey.

Hawaii.—An investigation of ground water in the Kau district, Hawaii, was nearly completed by Mr. Clark prior to his resignation, December 31, 1921, but the report has not yet been submitted.

Idaho.—The investigation of the water resources of the Mud Lake basin, Idaho, begun in 1921, was carried on during the year by Mr. Stearns, who did the geologic work, and L. L. Bryan, of the surface-water division, who did the engineering work. A preliminary mimeographed report was issued early in July. Financial cooperation was received from the Idaho Department of Reclamation, the United States General Land Office, and the Idaho Bureau of Mines and Geology. The survey of artesian basins in the State was continued in cooperation with the State Bureau of Mines and Geology. The report on the Goose Creek basin was completed by A. M. Piper, of that bureau, which is to publish it as Bulletin 6. An investigation was also made by Mr. Piper of certain artesian basins in Owyhee County, and a report is being prepared on these basins.

Maryland.—A brief examination of the ground-water conditions in the vicinity of Braddock Heights, Md., was made by G. M. Hall, and advice was given as to methods of increasing the water supply for that community.

Mississippi.—A report on ground water in Mississippi, prepared in cooperation with the geologic branch by L. W. Stephenson, E. N. Lowe, and G. A. Waring, was completed and is to be published as a water-supply paper.

Montana.—A report on the geology and water resources of the Townsend Basin, Mont., was completed by J. T. Pardee, of the geologic branch; a report on Yellowstone and Treasure counties was nearly completed by Mr. Hall; and a report on Big Horn County was partly prepared by Mr. Hall. All these reports are to be published as water-supply papers. Field work was begun by Mr. Hall in Fergus County.

Nevada.—Examinations of the artesian and other ground-water conditions near Orovada, Winnemucca, and Hawthorne, Nev., and of dam sites in Paradise Valley were made by Mr. Bryan. Brief manuscript or mimeographed reports were issued on most of these areas.

New Jersey.—An intensive study of the ground-water resources of New Jersey was undertaken in cooperation with the State Department of Conservation and Development. A preliminary field examination was made by Messrs. Meinzer and Thompson in April, and active field work was begun by Mr. Thompson July 1, 1923.

New Mexico.—Mr. Bryan examined the ground-water conditions in the vicinity of Clayton, N. Mex., and submitted to the city authorities a brief report on methods of increasing the public water supply.

North Carolina.—A report on the hydrology of the experiment field of the Public Health Service at Fort Caswell, N. C., was made to that service by Miss Dowell, based on field work in May, 1922.

North Dakota.—Progress was made by H. E. Simpson, State water geologist, on a report on ground water in North Dakota. This work is being done in cooperation with the State Geological Survey. Data were collected by correspondence on the decline of the artesian head in the Edgeley and Lamoure

quadrangles for use in a report prepared on this area for the geologic branch by Herbert Hard.

South Carolina.—Progress was made on a report on ground water in the Coastal Plain of South Carolina by C. W. Cooke, of the geologic branch.

Texas.—Additional work was done on a report on the Coastal Plain of Texas southwest of Brazos River by Alexander Deussen.

DIVISION OF QUALITY OF WATER.

The division of quality of water makes analyses of the mineral content of surface and ground waters and interprets such analyses with reference to geologic conditions and to the utilization of the waters in so far as it is affected by their chemical composition. During the year 275 samples of water were analyzed and laboratory studies were made of several analytical methods. A report showing the chemical composition of the water of public supplies used by nearly 39,000,000 persons in 307 cities in the United States was published as Water-Supply Paper 496. Discussions of quality of water were prepared for reports on the New Haven area, Conn.; on Yellowstone and Treasure counties, Mont.; and on the State of North Dakota. Analyses were made for reports on ground water in Owyhee County, Idaho; Fergus County, Mont.; and the Coastal Plain of South Carolina; and for five geologic folios covering areas in Pennsylvania. Manuscripts of two reports and proofs of three reports were examined with reference to statements in regard to quality of water. The report on production of mineral waters in 1921 was prepared.

DIVISION OF POWER RESOURCES.

The work of the division of power resources during the year comprised the preparation of monthly reports of the production of electricity and consumption of fuel by public-utility power plants, of State maps showing the location of the power stations and transmission lines used in public service, and of reports on the stock of coal on hand at electric public-utility plants at different dates.

The monthly reports are based on reports submitted by public-utility companies. About 3,900 power plants, each having a monthly output of 10,000 kilowatt-hours or more, are requested to submit reports of their production of electricity and consumption of fuel. The total capacity of the generators in these plants in March, 1923, was about 16,150,000 kilowatts. Reports received represent over 95 per cent of the total generating capacity of these plants. Each report is published about 30 days after the end of the last month included in it. The following tables show the power and fuel statistics for the calendar years 1919 to 1922:

Electricity produced at public-utility power plants in the United States, 1919-1922.

Year.	Total.		Water power.			Fuel power.		
	Kilowatt-hours.	Change from previous year (per cent).	Kilowatt-hours.	Per cent of total.	Change from previous year (per cent).	Kilowatt-hours.	Per cent of total.	Change from previous year (per cent).
1919.....	38,921,000,000	.....	14,606,000,000	37.5	.....	24,315,000,000	62.5	.....
1920.....	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921.....	40,976,000,000	-5.9	14,971,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922.....	47,659,000,000	+16.3	17,206,000,000	36.1	+14.9	30,453,000,000	63.9	+17.1

Fuel consumed in the production of power at public-utility plants in the United States, 1919-1922.

Year.	Coal.		Fuel oil.		Gas.	
	Short tons.	Change from previous year (per cent).	Barrels.	Change from previous year (per cent).	M cubic feet.	Change from previous year (per cent).
1919.....	35,100,000	.....	11,050,000	.....	21,406,000	.....
1920.....	37,124,000	+5.8	12,123,000	+18.8	24,702,000	+15.4
1921.....	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.0
1922.....	34,179,000	+8.3	13,197,000	+9.6	27,172,000	+14.5

Maps of West Virginia and Kentucky showing the location of the power stations and transmission lines used in public service and the names of the public-utility companies and their plants were published. The preparation of maps of other States and the revision of maps already published has not been undertaken on account of lack of funds for the continuation of this work.

Reports on the stock of coal held by electric public-utility power plants were made for inclusion in reports on commercial stocks of coal undertaken by the Bureau of the Census, Department of Commerce, and the Geological Survey under authority of the Federal Fuel Distributor. Seven of these reports were prepared during the year giving the stock of coal held on the first day of the months of September, October, and November, 1922, and January, February, March, and June, 1923.

DIVISION OF ENLARGED AND STOCK-RAISING HOMESTEADS.

The work of the division of enlarged and stock-raising homesteads comprises two distinct classes—the examination of public lands for designation under the enlarged and stock-raising homestead laws and the examination of streams and neighboring lands as a basis for the classification of public lands with respect to their value for water power or irrigation.

Owing to a reduction in the appropriation for the classification of lands during this fiscal year only 9 classifiers out of a force of 15 were retained at the beginning of the year for the examination of

lands to be classified under the stock-raising homestead law. Further plans to meet the reduction in appropriation had been made at the beginning of the field season, and the classifiers who in previous years had examined only lands applied for under the stock-raising homestead law were assigned also to the examination of lands subject to entry under enlarged-homestead laws.

Field examination under these laws was confined mainly to lands for which applications had already been made, but in all the States in which work was done reconnaissance examinations were made of block areas, including considerable land not covered by applications. During the summer of 1922 the lands in the following States included in applications pending at the beginning of the year were examined:

Arizona: All districts.

California: Practically all districts.

Colorado: Glenwood Springs, Durango, and Denver districts and most of Del Norte, Leadville, Montrose, and Pueblo districts.

Idaho: Blackfoot, Boise, and Hailey districts.

Kansas: Western part.

Montana: Billings, Bozeman, Glasgow, Great Falls, Havre, and Lewistown districts and most of Miles City district.

Nebraska: Northwestern part.

New Mexico: Santa Fe district.

North Dakota: All districts.

Oregon: All districts.

South Dakota: All districts.

Utah: Vernal district and most of Salt Lake City district.

Washington: All districts.

Wyoming: Buffalo, Lander, Douglas, and Evanston districts and most of Cheyenne and Newcastle districts.

During the field season of 1923 work was begun early in June by the force assigned to the examination of lands under the homestead laws and at the end of the month was in progress in California, Colorado, Idaho, Montana, Oregon, South Dakota, Utah, and Wyoming.

The reconnaissance examination of lands withdrawn for power sites along Arkansas River and its headwater tributaries west of Pueblo, Colo., in progress in the previous fiscal year, was completed early this year.

A reconnaissance of the power-site value of lands in the Eel and Mad River basins, California, begun in the previous year, was completed in the summer of 1922.

An examination of Colorado River between Halls Crossing, Utah, and Lees Ferry, Ariz., a distance of about 120 miles, was made for the purpose of surveying in detail certain possible dam sites disclosed by maps made from the previous year's surveys. The power sites at the mouth of Diamond Creek and on the lower portion of the river from Boulder Canyon to Needles were also examined.

A study of the possibilities of irrigation in Arizona by means of Colorado River was made in cooperation with the State of Arizona, which created the Arizona Engineering Commission, consisting of E. C. La Rue, of the Geological Survey, chairman; P. J. Preston, of the Reclamation Service; and H. E. Turner, of the State engineer's office. This commission has made reconnaissance surveys and studies of three or more projects of great magnitude for diverting and using the waters of the river for irrigation in Arizona, and a

report thereon was submitted to the governor of Arizona at the end of the fiscal year.

In order to designate dam sites for detailed survey and to obtain information necessary for preparing a report on the water-power and reservoir possibilities of Green River between Green River, Wyo., and Green River, Utah, an engineer was attached to a topographic party making a survey of that stretch of the river; another engineer was attached to a topographic party making a survey of Yampa River, a tributary of Green River, from Juniper reservoir to the mouth of the river in Colorado; and two other engineers are attached to the topographic parties that are now mapping Rogue River and its tributaries in Oregon.

In Montana a survey of the South Fork of Flathead River from the Hungry Horse ranger station to the mouth of the river, a distance of about 10 miles, was made for the purpose of locating a power site, and an examination is now in progress as to the present use of water for power and irrigation and the possible future use of water, principally for irrigation, in the drainage area of Missouri River above the mouth of Portage Creek (12 miles below Great Falls).

An engineer was detailed for about two months as a member of a board to review the Milk River project of the Reclamation Service and to make a report and recommendations to the Secretary of the Interior.

A reconnaissance survey has been made of South Platte River above the north line of T. 7 S., R. 69 W., Colorado, in order to ascertain the power value of the stream and adjoining lands. A similar survey is now in progress along Sweetwater River, Wyo.

An office study is being made of the water supply of streams flowing to the Pacific coast between the Klamath and Columbia River basins in Oregon and California.

Manuscript reports, based on surveys made in previous years, on the water-power possibilities of Snake River from Milner to Weiser, Idaho, and from Huntington, Oreg., to Lewiston, Idaho; of Salmon River from Salmon, Idaho, to the mouth of the river; and of Big Horn River between Lovell, Wyo., and Hardin, Mont., were prepared in the expectation that they will be published as water-supply papers. As there will be considerable delay in the publication of these reports, manuscript copies have been placed in local offices and the Washington office of the Geological Survey for inspection by the public. A report on the utilization of Klamath River, Oregon and California, completed a year ago, has likewise been made available for public inspection.

LAND-CLASSIFICATION BRANCH.

ORGANIZATION AND PERSONNEL.

The work of the land-classification branch consists of classification based on mineral character, on water supply, and on value as stock-raising homesteads. The corresponding units of organization are the division of mineral classification, the division of hydrographic classification, and the division of homestead classification. The division of hydrographic classification includes two sections, each dealing with a type of classification work in which water sup-

ly is an essential element. At the end of the fiscal year the organization and the technical personnel were as follows:

Chief, Herman Stabler.

Assistant chief, J. D. Northrop.

Chief clerk, Elsie Patterson.

Division of mineral classification: J. D. Northrop, geologist, chief; C. D. Avery, mining engineer; G. W. Holland and N. W. Bass, classifiers; W. W. Boyer, associate geologist.

Division of hydrographic classification: W. G. Hoyt, hydraulic engineer, chief. Power section: B. E. Jones, hydraulic engineer, chief; N. J. Tubbs, engineer; E. E. Jones and R. O. Helland, classifiers; Warren Oakley, assistant engineer. Irrigation section: J. F. Deeds, hydraulic engineer, chief; C. E. Nordeen, topographic engineer; W. N. White, classifier.

Division of homestead classification: A. E. Aldous, classifier, chief; J. G. Mathers, engineer; W. L. Hopper, classifier.

In addition two engineers, R. W. Davenport and D. J. Guy, have been detailed from the branch for duty with the Federal Power Commission.

During the year there were 3 additions to the force and 8 separations. At its end the total number of persons on the regular staff, including the clerical force and employees detailed to the Federal Power Commission, was 48. In addition to this regular force 9 classifiers on the rolls of the water-resources branch joined the staff of the land-classification branch during the office season in connection with the stock-raising homestead classifications.

SCOPE AND CHARACTER OF THE WORK.

The land-classification branch was organized to perform the duties relating to "the classification of public lands" with which the Geological Survey is charged by the law of March 3, 1879 (20 Stat. 394). Since its organization the branch has prepared and recommended withdrawals of lands known or believed to be valuable for coal, planned their examination, classified and appraised them, and initiated their restoration to the public domain for disposal in accordance with their classification. It has recommended the creation of oil, phosphate, and potash reserves pending the enactment by Congress of appropriate laws for the disposition of the minerals involved. It has classified large areas of oil-shale lands and has selected lands to be set aside as oil and oil-shale reserves for the Navy and drafted orders for their withdrawal. It has formally classified as to all minerals all or parts of several Indian reservations and as to metalliferous minerals extensive areas of lands within the Northern Pacific Railroad grant. It has initiated withdrawals of lands valuable for the development of water power in order to prevent possible serious interference with their use for that purpose, and it bears an important part in facilitating the utilization of the withdrawn lands for water-power development. It prepares and recommends designations required prior to allowance of applications for entry of lands under the enlarged and stock-raising homestead acts and the Nevada ground-water reclamation act.

Under the mineral leasing act of February 25, 1920 (41 Stat. 437), deposits of coal, phosphate, sodium, oil, oil shale, or natural gas and lands containing them, whether classified or included in mineral reserves on recommendation of the branch or whether unclassified

or unreserved, are subject to prospecting under permit or to lease. The branch is required to define the "known geologic structure" of producing oil or gas fields, to determine what is leasing and what is prospecting ground, to recommend the creation of leasing units, to suggest appropriate requirements as to royalty, minimum annual production, and minimum investment, and generally to make the classifications and to give advice on the geologic and economic problems that must be solved to render the leasing act effective.

The tasks that arise in connection with the work above outlined are performed on the basis of records accumulated by the Survey in mapping the topography and investigating the mineral and water resources of the public domain since its creation in 1879. If existing records are deficient and can not be supplemented satisfactorily from other scientific sources, the branch prepares plans for field investigation and makes an allotment from its funds to such other branch of the Survey as is best equipped to obtain the needed information. In a sense the land-classification branch is a repository of essential data relating to the natural resources of the public domain and a clearing house for information of many types required in the administration of the laws enacted by Congress and the policies adopted by the Executive for the conservation and utilization of those resources.

The greater part of the information disseminated by the branch is utilized through the General Land Office and the office of the Secretary of the Interior, where such facts as to the character of lands are needed as a basis for the administration of certain laws and the development of certain policies. Much of the land-classification work is done under a plan of procedure arranged with the General Land Office, which involves the submission of technical reports on numerous types of cases before that office and the department for disposal. Other bureaus and offices of the Interior Department, as well as other departments of the Government, are also supplied with information pertaining to the character of the public domain.

FUNDS.

The act of May 24, 1922 (Public No. 224, 67th Congress), appropriated \$225,000 for classification of lands by the Geological Survey in the fiscal year ended June 30, 1923, a reduction of \$75,000 from the appropriation for the preceding year that has been inevitably reflected in the amount of work accomplished. The major part of the appropriation was expended for special field examinations necessary as a prerequisite to classification of lands, somewhat less than half being used for general administration and the office work of classifying and reporting on character of lands.

As an offset to the reduced appropriation, the act of January 24, 1923 (Public No. 395, 67th Congress), made available on the date of its approval the sum of \$280,000 to be expended for land classification prior to June 30, 1924. Only a small part of this appropriation was utilized during the current year, as the seeming advantage of its early availability was largely discounted by climatic conditions in most of the public-land States which prevented the start of many urgently needed field investigations until after the beginning of the ensuing fiscal year.

CORRESPONDENCE.

During the year 16,523 letters and petitions were received by the land-classification branch. In addition 5,600 copies of miscellaneous correspondence were sent to the branch for its information and filing; this correspondence was made up largely of letters from the General Land Office to its local officers and of reports on the character of lands by its inspectors and examiners, copies of decisions rendered by the Department of the Interior, and copies of withdrawals and restorations recommended by the Reclamation Service. Within the same period 11,697 letters were prepared by the branch. These figures show an average of 54 incoming letters and of 38 outgoing letters for each working day of the year.

SUMMARY OF CASES.

The information supplied by the branch is furnished either in reports submitted in response to specific requests for data or in the form of broad areal classifications made under the laws relating to the public domain and its natural resources. The following table gives a summary of the cases before the branch for action during the year and indicates that reports were rendered on more than 15,000 specific requests. The mere number of cases disposed of, however, is not a true index to the magnitude of tasks accomplished, for some cases require only a few minutes' consideration, whereas others require exhaustive study and research extending over several days or weeks, and some necessitate field investigations. The terms "gain" and "loss" in the table signify, respectively, decrease and increase in the number of cases pending.

General summary of cases, land-classification branch.

Class of cases.	Record for fiscal year 1922-23.						Record since receipt of first case.	
	Pending July 1, 1922.	Received during fiscal year.	Total.	Acted on during fiscal year.	Pending June 30, 1923.	Gain or loss during fiscal year.	Received.	Acted on.
General Land Office requests.....	882	1,440	2,322	1,839	483	+399	.....	.....
Applications for classification as to mineral:								
Coal.....	26	19	45	27	18	+8	743	725
Oil.....	132	800	932	813	119	+13	2,378	2,269
Phosphate.....	1	2	3	2	1	.....	30	29
Applications for mineral permits.....	713	4,838	5,551	4,932	619	+94	20,729	20,110
Applications for mineral leases.....	47	217	264	229	35	+12	460	425
Applications for patent, potassium.....	.....	3	3	1	2	-2	17	15
Federal Power Commission cases:								
Preliminary permits.....	2	5	7	6	1	+1	40	39
Licenses.....	1	.....	1	1	1	.....	12	11
Determinations under sec. 24.....	2	8	10	3	7	-5	61	54
Applications for reclassification as to water resources.....	7	11	18	11	7	.....	628	621
Applications for rights of way.....	9	143	152	124	28	-19	5,239	5,211
Irrigation project reports.....	9	16	25	21	4	+5	872	868
Applications under enlarged-homestead acts.....	723	785	1,508	930	578	+145	54,322	53,744
Applications under stock-raising homestead act.....	3,901	5,391	9,292	6,338	2,954	+947	105,470	102,516
Applications under ground-water reclamation act.....	42	106	148	103	45	-3	694	649
Indian Office requests for information.....	5	11	16	13	3	+2	9,486	9,483
Cases in national forests.....	2	9	11	10	1	+1	283	282
	6,504	13,804	20,308	15,402	4,906	+1,598	.....	.....

DIVISION OF MINERAL CLASSIFICATION.

The activities of the division of mineral classification are directed along three primary lines of effort involving, first, the withdrawal, classification, and restoration of public lands based on mineral character; second, the solution of geologic and economic problems arising in the administration of the acts that provide for leasing of mineral lands; and, third, the preparation of reports concerning the mineral character of specific lands for the information and guidance of other Government bureaus charged with the administration of the public land and Indian land laws.

Despite the preoccupation of the division with urgent problems pertaining to the second phase of its activities, some progress was made during the year along the broader lines of mineral-land classification.

The approval of the potash-land leasing act in October, 1917, and of the general mineral-lands leasing act in February, 1920, opened to disposition the deposits of coal, oil, gas, phosphate, oil shale, sodium, and potash in some 50,000,000 acres then embraced in outstanding mineral-land withdrawals, but it did not obviate the necessity for the classification of these lands and their restoration to the public domain. To this unfinished task the mineral division is devoting as much energy as the limitations imposed by small personnel, inadequate geologic information, and pressure of more urgent tasks will permit. The results accomplished in the fiscal year include a net increase of 6,620 acres in the total area previously classified as coal land, and decreases of 408,123 acres in the area of outstanding coal withdrawals, of 162,949 acres in the area of outstanding petroleum reserves, and of 40 acres in the area of outstanding phosphate reserves. No change was effected during the year in the areas previously classified as oil land, withdrawn or classified as oil-shale land, classified as phosphate land, included in potash reserves, or withdrawn on account of concealed deposits of metalliferous minerals.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications, June 30, 1923, in acres.

State.	Coal.		Oil.	
	Withdrawn.	Classified as coal land.	Withdrawn.	Classified as oil land.
Alaska.....		56,993		
Arizona.....	141,243		230,400	
Kansas.....		61,160		
California.....	17,643	8,720	1,178,392	
Colorado.....	4,241,552	3,170,645	222,977	
Idaho.....	4,761	4,603		
Louisiana.....			466,990	
Montana.....	10,510,700	6,591,821	1,350,426	42,097
Nevada.....	83,833			
New Mexico.....	5,220,594	582,684		
North Dakota.....	5,954,364	11,178,286	84,594	
Oregon.....	4,361	18,887		
South Dakota.....		250,093		
Utah.....	5,068,832	1,101,587	1,870,627	
Washington.....	601,852	141,444		
Wyoming.....	2,437,283	6,736,183	1,018,898	
	34,367,008	29,903,106	6,423,604	42,097

State.	Oil shale.		Phosphate.		Potash (with-drawn).
	With-drawn.	Classified as oil-shale land.	With-drawn.	Classified as phosphate land.	
California.....					90,518
Colorado.....	41,560	952,239			
Florida.....			119,523		
Idaho.....			720,534	267,722	
Montana.....			257,883		
Nevada.....	123				39,422
Utah.....	86,584	2,705,035	302,465		
Wyoming.....		460,103	995,049	25,293	
	128,267	4,117,377	2,425,454	293,015	129,940

The contributions of the mineral division to the administration of the mineral-lands leasing acts are fundamental and important. They involve, with respect to coal, the determination whether a prospecting permit or a lease should be issued and, if a lease is required, the establishment of a leasing unit consistent in area and content of coal with the mining operation to be undertaken and the recommendation of appropriate stipulations in the matters of royalty, minimum investment, and minimum annual production. With respect to oil and gas they require the definition of the "known geologic structure" of producing oil or gas fields as the primary distinction between leasing and prospecting areas, the determination of the structural relations of lands embraced in prospecting-permit applications, and the classification of all tracts included in such applications which are at the same time involved in unperfected entries under the nonmineral-land laws. Similar types of essential service involving decisions based on geologic evidence are rendered in the administration of the potash-land leasing act and the sections of the general mineral-lands leasing act pertaining to phosphate, oil shale, and sodium.

The following table summarizes the year's activities of the division to the extent that they involve the consideration of specific applications for permit or lease rights under the leasing acts:

Applications under the mineral-leasing acts, fiscal year 1922-23.

Mineral.	Permits.			Leases.			Patents.		
	Re- ceived.	Acted on.	Pend- ing.	Re- ceived.	Acted on.	Pend- ing.	Re- ceived.	Acted on.	Pend- ing.
Oil and gas.....	4,443	4,369	536	32	27	5	.....	.....	.....
Coal.....	347	498	83	174	194	23	.....	.....	.....
Phosphate.....	.....	.....	.....	6	6	1	.....	.....	.....
Sodium.....	7	9	.....	.....	.....	.....	.....	.....	.....
Potassium.....	41	56	.....	.....	1	.....	3	1	2
Oil shale.....	.....	.....	.....	5	1	6	.....	.....	.....

The broader phases of the division's activities under the leasing acts were restricted during the year almost entirely to the designations of the boundaries of the "known geologic structure" of producing oil and gas fields—that is, the designation of the lands that are subject to lease only as distinguished from those on which prospecting permits may be granted. The results, which involve an exhaustive study of each area considered, include definitions of the White River and Williams Park Anticline gas fields, Colo.; Shelby gas field and Gas Ridge and Kevin-Sunburst oil fields, Mont.; Big Polecat and Little Polecat gas fields and Derby Dome oil field, Wyo.; and of extensions of the McKittrick, Buena Vista Hills, and Midway oil fields, Calif. At the end of the year 46 fields, having a total area of 421,066 acres, had been defined.

Reports rendered in response to requests of the General Land Office and the Office of Indian Affairs for information concerning the mineral possibilities of specific lands have been brought to and maintained at a current basis. The general summary of cases shows a net gain of 399 such cases involving reports to the General Land Office and of 2 cases involving reports to the Office of Indian Affairs.

In all the types of activity pursued by the division the requisite of definite information on which to base decisions and recommendations of appropriate action has necessitated the planning and financing of considerable field work, both reconnaissance and detailed, undertaken by the geologic and topographic branches.

Important items of field work to obtain data for mineral classification in progress at the request of the land-classification branch and financed in whole or in part by allotments from its funds during the year are (1) general geologic investigations on the north and east flanks of Bearpaw Mountains and in an area west of the Crow Indian Reservation, Mont.; in a large area east and northeast of Kanab, Kane County, Utah; in a large area in Moffat County, Colo., and adjacent parts of Sweetwater County, Wyo.; on the west and north-west flanks of the Black Hills in Wyoming and Montana; and in the northern part of the Big Horn Basin, Wyo.; (2) detailed studies of the occurrence of coal in the Dawson County lignite field, Mont.; the Tongue River and Armells Creek districts of the Powder River basin coal field, Mont.; the eastern part of the Yampa River, Danforth Hills, Grand Hogback, and Little Book Cliffs coal fields, Colo.; the Rio Puerco and Monero coal districts of San Juan Basin, N. Mex.; the southern and western parts of the Wasatch Plateau and western part of the Book Cliffs coal fields, Utah; and the Gillette, Upper Powder River Basin, and Gebo coal fields, Wyo.; (3) detailed

dies of oil and gas possibilities in the Douglas River and Cold y regions, Alaska; the Kern River district, Calif.; the southern t of the Sweetgrass arch, Mont.; the Bates Hole, Baxter Basin, ly Creek, Golden Eagle, and other districts, Wyo.; (4) a general onnaissance of phosphate resources in Florida, in southeastern ho, and in the Mission Range area in Montana; and (5) an inves- ation of the occurrence of oil shale in a small area near Medford. eg.

DIVISION OF HYDROGRAPHIC CLASSIFICATION.

POWER SECTION.

The work of the power section consists primarily in obtaining and king available for administration under the public-land laws in- mation as to the water-power resources of the public lands. Re- ts are made on specific problems as they arise, such problems linarily involving conflict between projects for power development l applications under the land laws. The endeavor is made to ch solutions by which the possibilities for developing power may preserved with a minimum of interference with agricultural, nsportation, or other interests. In connection with these specific bblems and also in a broad way, constant review is being made of ver reserves in order that all land having material value for the velopment of power, and only such land, shall be held reserved t that purpose. The extent of this task is indicated by the fact t over 4,600,000 acres of land is included in power reserves whose ill be required for the development of about 15,000,000 con- uous horsepower.

n order that its information may be substantially complete, the tion designates areas not thoroughly surveyed for examination by field branches of the Survey. Important items of field work to ain data for power classification, in progress at the request of the d-classification branch and financed by allotments from its funds ing the year, include (1) plan and profile surveys and power-site estigations of Green River from Green River, Wyo., to Green ver, Utah; Yampa River, Colo., from Craig to mouth; portions of orado River in Arizona, California, and Utah; Rogue River, eg.; and (2) detailed studies and reports on the possibilities of eloping power in the Eel and Mad River basins, Calif.; upper ith Platte and Arkansas River basins, Colo.; Missouri and Flat- d River basins, Mont.; coast streams in Oregon; and Encamp- nt and Sweetwater rivers, Wyo. All such information as it be- es available is carefully indexed and incorporated in an inven- y of water resources maintained by the land-classification branch, ich, when complete, will enable the section to give competent ad- e on short notice as to the manner in which each tract of public d having value for power can best be used in connection with the elopment of water power and as to the relation of such use to er possible uses of the tract.

The work of the section, in so far as it is readily subject to statis- al record, is briefly summarized in the table of power-site reserves, table of outstanding water-resources withdrawals and classifica- is, and the general summary of cases. Certain features of the rations under power permits and grants issued prior to the pas-

sage of the Federal water-power act, as disclosed by reports made on request of the section, are summarized in the following paragraph:

Pursuant to the instructions of the Secretary, dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted by the Secretary of the Interior since January 1, 1913, were called upon for detailed reports of the operations or developments of their power systems during the calendar year 1922. An examination of these reports shows that the total installation of the 59 reporting companies is 1,410,000 kilowatts, of which 1,129,000 kilowatts is installed at hydroelectric plants. The total energy generated amounted to 4,947,000,000 kilowatt-hours, of which 4,629,000,000 kilowatt-hours was generated by water power. The operating expenses for the companies generating 100,000,000 kilowatt-hours or more a year (90 per cent of which was generated by water power), including taxes and depreciation, averaged 7.4 mills per kilowatt-hour sold. The gross income from electrical operations of the same companies was 15 mills per kilowatt-hour of energy sold.

Power output of permittees and grantees, 1916-1922.

Year.	Number reporting.	Kilowatt-hours.	Increase or decrease.	
			Kilowatt-hours.	Per cent.
1916.....	26	1,200,000,000	.....	.....
1917.....	32	2,000,000,000	+800,000,000	+67
1918.....	51	3,200,000,000	+1,200,000,000	+60
1919.....	57	3,100,000,000	-100,000,000	-3
1920.....	56	4,200,000,000	+1,100,000,000	+35
1921.....	56	3,725,000,000	-475,000,000	-11
1922.....	59	4,947,000,000	+1,222,000,000	+32

Power-site reserves, in acres.

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction.]

State.	Reserved prior to July 1, 1922.	Eliminated prior to July 1, 1922.	Reserves outstanding prior to July 1, 1922.	Reserved during fiscal year.	Eliminated during fiscal year.	Reserves outstanding June 30, 1922.
Alabama.....	749	.....	749	.....	.....	749
Alaska.....	151,765	520	151,245	16,476	.....	167,721
Arizona.....	1,103,239	105,194	998,045	58,471	.....	1,056,516
Arkansas.....	28,469	.....	28,469	.....	.....	28,469
California.....	817,345	18,252	799,093	135,727	.....	934,820
Colorado.....	323,752	48,246	275,506	18,654	8	294,162
Florida.....	486	.....	486	.....	.....	486
Idaho.....	399,603	165,351	234,252	41,333	7,116	268,469
Michigan.....	1,240	.....	1,240	.....	.....	1,240
Minnesota.....	12,841	532	12,309	.....	.....	12,309
Montana.....	250,819	78,126	172,693	32,762	360	205,095
Nebraska.....	761	.....	761	.....	.....	761
Nevada.....	272,596	280	272,316	27,826	.....	300,142
New Mexico.....	215,181	6,537	208,644	.....	.....	208,644
Oregon.....	506,846	65,283	441,563	5,449	13,619	433,403
South Dakota.....	12	.....	12	.....	.....	12
Utah.....	588,672	117,812	471,860	.....	3,900	467,960
Washington.....	176,060	35,841	140,219	2,351	5,164	137,406
Wisconsin.....	1,096	226	870	.....	.....	870
Wyoming.....	216,923	67,646	149,277	160	452	149,085
	5,068,485	709,246	4,359,239	339,209	30,119	4,668,329

*Summary of outstanding water-resources withdrawals and classifications
June 30, 1923, in acres.*

State.	Power reserves.					Reservoir with- drawals.	Public water with- drawals.	Ground- water reclama- tion designa- tions.
	With- drawals.	Classifi- cations.	Designa- tions. ^a	Miscel- laneous.	Total.			
Alabama.....	120	190		439	749			
Alaska.....	93,415	3,478		70,828	167,721			
Arizona.....	302,208	37,182	528,245	188,881	1,056,516	23,040	14,521	
Arkansas.....	22,354	1,590		4,525	28,469			
California.....	297,105	69,969		567,746	934,820	1,160	68,188	
Colorado.....	252,502	18,368		23,282	294,152	1,728	1,620	
Florida.....				486	486			
Idaho.....	224,439	38,589		5,441	268,469		12,000	
Michigan.....	1,240				1,240			
Minnesota.....	12,309				12,309			
Montana.....	147,837	35,428		21,835	205,065	9,080	7,263	
Nebraska.....	761				761			
Nevada.....	27,643	27,786		244,813	300,142		10,126	1,300,940
New Mexico.....	65,483		143,161		208,644		8,366	
North Dakota.....						1,569		
Oregon.....	401,661	1,863	15,891	14,078	433,493	10,619	14,311	
South Dakota.....				12	12		240	
Utah.....	447,270	1,792		18,798	467,860	80	33,376	
Washington.....	109,006	6,702		21,728	137,436	35,943	920	
Wisconsin.....				870	870			
Wyoming.....	88,239	20,351		40,495	149,085	1,714	81,905	
	2,493,492	263,283	687,297	1,224,257	4,668,329	84,933	253,086	1,300,940

^a Designated and not otherwise withdrawn.

IRRIGATION SECTION.

The primary work of the irrigation section is classification of lands with respect to irrigability under the enlarged and stock-raising homestead acts and the Nevada ground-water reclamation act. The greater portion of the thousands of applications for lands under these acts received are disposed of on the basis of data obtained through field examinations by the technical force of the branch and office information gathered from various sources bearing upon the matter of water supplies and irrigation. Broad areal classifications are made as far as practicable, and in consequence a number of applications are disposed of at the time of filing, thus decreasing the number of incoming cases. Cases that can not be handled otherwise are listed for field examination, and reports are made which not only serve as a basis for action upon the particular cases but often prove helpful in the consideration of applications embracing land in the immediate vicinity. Additional broad field studies in critical areas are planned for execution by the field branches when required and financed by allotments from the funds of the branch. During the year such studies were in progress in the Snake River Plains of southern Idaho, in four or five counties of eastern Montana, and in the Missouri River drainage area in Montana.

The section initiates designations of land appropriate for entry under the Nevada ground-water reclamation act, and during the year the area so designated was increased from 1,109,000 to 1,300,940 acres.

The section also makes reports on the sufficiency of water supply and general feasibility of irrigation projects that require some form

of Federal approval in connection with the administration of the public-land laws, and it initiates the withdrawal of lands for reservoir sites.

The tables relating to enlarged and stock-raising homestead designations and the general summary of cases show briefly the results of many features of the work of the section.

Summary of enlarged-homestead designations, in acres.

[Areas classified as arid and nonirrigable, residence by entrymen required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 122), applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat. 953), applicable to Kansas; act of Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho).]

State.	Designations prior to July 1, 1922.	Cancellations prior to July 1, 1922.	Designations outstanding prior to July 1, 1922.	Designations during fiscal year.	Cancellations during fiscal year.	Designations outstanding June 30, 1922.
Arizona.....	31, 016, 679	5, 409, 474	25, 607, 205	224, 290	.....	25, 841, 495
California.....	12, 982, 601	238, 320	12, 744, 281	108, 065	.....	12, 852, 346
Colorado.....	32, 762, 497	184, 960	32, 577, 537	364, 979	28	32, 942, 488
Idaho:						
Total.....	13, 424, 381	453, 405	12, 970, 976	80, 820	a 2, 880	13, 048, 916
Nonresidence.....	563, 787	4, 233	559, 554	3, 440	.....	562, 994
Kansas.....	637, 734	.....	637, 734	6, 340	.....	644, 074
Montana.....	53, 101, 706	244, 282	52, 857, 424	92, 779	.....	52, 950, 203
Nevada.....	50, 015, 275	3, 564, 797	46, 450, 478	104, 875	.....	46, 555, 353
New Mexico.....	43, 035, 939	227, 732	42, 808, 207	378, 905	.....	43, 187, 112
North Dakota.....	12, 262, 870	3, 848	12, 259, 022	4, 840	.....	12, 263, 862
Oregon.....	21, 164, 514	984, 702	20, 179, 812	43, 810	4, 760	20, 218, 862
South Dakota.....	16, 321, 265	348, 170	15, 973, 095	3, 270	.....	15, 976, 365
Utah:						
Total.....	10, 849, 264	369, 975	10, 479, 289	394, 295	b 13, 120	10, 860, 464
Nonresidence.....	1, 584, 454	21, 840	1, 562, 614	16, 800	960	1, 578, 454
Washington.....	6, 581, 875	251, 842	6, 330, 033	13, 130	.....	6, 343, 163
Wyoming.....	28, 799, 728	156, 256	28, 643, 472	248, 420	5, 428	28, 886, 464
	332, 956, 328	12, 437, 763	320, 518, 565	2, 078, 818	26, 216	322, 571, 167

a 2,880 acres previously designated under secs. 1-5 now designated under sec. 6.

b 12,160 acres previously designated under secs. 1-5 now designated under sec. 6.

DIVISION OF HOMESTEAD CLASSIFICATION.

The stock-raising homestead law requires that prior to entry under its terms the land shall be classified as nontimbered, nonirrigable, valuable chiefly for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family. The division of homestead classification determines what lands shall be so classified, except as to irrigability, which is determined by the irrigation section of the division of hydrographic classification. The nature of the classification is so complex that in many extensive areas detailed information concerning the particular tract applied for is essential. Field examination of individual tracts by the water-resources branch is therefore planned by this division and financed by allotments from the funds appropriated for classification of lands. Broad areal classification, after general reconnaissance, is applied wherever practicable, thus reducing the number of detailed field investigations to a minimum.

Under instructions of the Secretary of the Interior the division is cooperating with the Department of Agriculture in preparing a

report on the agriculture and the utilization of land in the northern Great Plains region.

Reservation and restoration of tracts valuable for watering stock is also a duty of this division. During the year additions to public water reserves embraced 570 acres in Arizona, 480 acres in California, 40 acres in Colorado, 40 acres in Idaho, 80 acres in Montana, 120 acres in Nevada, 2,085 acres in New Mexico, 1,320 acres in Oregon, and 40 acres in Wyoming, and the cancellations of such reserves included 80 acres in California, 40 acres in Colorado, 160 acres in Idaho, 16 acres in Montana, 425 acres in Nevada, 210 acres in Oregon, 1,150 acres in Utah, and 320 acres in Wyoming. The areas remaining reserved as public watering places in the several States at the end of the year are shown in the table of outstanding water-resources withdrawals and classifications.

The general summary of cases and the summary of stock-raising homestead designations show in detail other features of the progress of the work of this division, which has been kept substantially current throughout the year.

Summary of stock-raising homestead designations, in acres.

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family (act of Dec. 29, 1916, 39 Stat. 862).]

State.	Designations prior to July 1, 1922.	Cancellations prior to July 1, 1922.	Designations outstanding prior to July 1, 1922.	Designations during fiscal year.	Cancellations during fiscal year.	Designations outstanding June 30, 1923.
Arizona.....	13,669,316	882,040	12,867,276	79,794	160	12,946,910
Arkansas.....	1,120		1,120			1,120
California.....	7,381,667		7,381,667	148,263		7,529,930
Colorado.....	7,089,107	8,890	7,090,227	389,845	360	7,469,712
Idaho.....	4,874,649	974	4,873,575	166,486	160	5,039,901
Kansas.....	101,434		101,434	6,425		107,859
Michigan.....	2,831		2,831	120		2,951
Montana.....	14,255,552	16,000	14,239,552	288,426	1,041	14,526,977
Nebraska.....	136,135		136,135	24,120		160,255
Nevada.....	418,309	2,800	415,509	15,816		431,325
New Mexico.....	30,507,100	600	30,506,500	332,255		30,838,755
North Dakota.....	329,832		329,832	24,598		354,430
Oklahoma.....	61,151		61,151	5,960		67,111
Oregon.....	5,900,159	1,048	5,899,111	136,830	1,360	6,034,581
South Dakota.....	6,393,647	390	6,393,257	43,600	160	6,436,697
Utah.....	990,768	240	990,528	89,714	640	1,079,602
Washington.....	592,423	1,134	591,289	46,110		637,399
Wyoming.....	18,870,983	3,080	18,867,903	454,107	1,854	19,320,156
	111,606,083	867,186	110,738,897	2,252,469	5,735	112,985,631

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 24,473 pages of manuscript were edited and prepared for printing, and proof sheets comprising 2,748 galley proofs and 20,628 page proofs were read and corrected. Indexes were prepared for 55 publications, covering 12,985 pages. Copy and proof or stencils for 1,010 pages of multigraph and mimeograph matter were read. The publications of the year are listed and abstracted on pages 5-14.

At the end of the fiscal year five persons were employed in this section. The water-resources branch has continued to render special assistance in preparing copy and reading proof.

SECTION OF ILLUSTRATIONS.

The number of drawings prepared was 4,052, including 186 maps, 1,543 sections and diagrams, 428 photographs, and 1,895 paleontologic drawings; 186 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany manuscripts numbered 956, to be reproduced by chromolithography, photolithography, half-tone, zinc etching, and cuts already engraved. The number of proofs received and examined was 1,630. At the end of the year material for illustrating 31 reports was on hand. There are now, as last year, 11 employees in the section.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

Geologic maps, structure sections, and other illustrations for 6 folios were drawn, edited, and prepared for publication and proofs of them were read during the year. Illustrations for 25 other reports in course of publication were examined and edited. Geologic maps and sections for several reports not yet submitted for publication were compiled for the authors and drawn.

One geologic folio (No. 214, Raton-Brilliant-Koehler, N. Mex.-Colo.) was completed and published. The 5 other folios in hand were well advanced toward completion. No new folios were received for publication during the year. The geologic map of Wyoming on the scale of 1 to 500,000 was received for preparation for publication, and editing was begun. The geologic map of Arizona on the same scale, prepared by the Arizona Bureau of Mines in cooperation with the United States Geological Survey, was also received for editing and preparation. The section was authorized to compile a geologic map of the United States on a scale of 1 to 2,500,000 for publication by the Geological Survey.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

During the year 70 topographic maps were edited and transmitted for engraving, 143 published topographic maps were edited for reprint, 41 plan and profile river-survey sheets were edited for photolithography, 16 miscellaneous maps were edited for engraving or photolithography, and 195 maps were edited as illustrations for Survey reports, a total of 465 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 424 were read and 185 proofs of maps reproduced by photolithography. At the end of the year 68 new topographic maps were in process of engraving and printing. Index maps for 12 State circulars were revised and proofs corrected. (See also "Topographic branch," p. 55.)

DIVISION OF DISTRIBUTION.

A total of 516 publications, comprising 152 new books and pamphlets, 15 reprinted books and pamphlets, 1 new geologic folio, 7 new geologic maps, Part I of the World Atlas of Commercial Geology reprinted, 133 new or revised topographic and other maps, and 207 reprinted topographic and other maps were received by the division of distribution during the year. A number of special pamphlets and forms prepared for administrative use were also delivered and distributed. The total units of all publications received numbered 482,951 books and pamphlets, 3,551 geologic folios, 3,000 copies of Part I of the World Atlas, 700 geologic maps, and 1,027,585 topographic and other maps, a grand total of 1,519,787.

The division distributed 470,491 books, 8,262 folios, 1,053 copies of the World Atlas (544 of Part I and 509 of Part II), and 741,116 maps, a total of 1,220,922, of which 7,237 folios, 848 copies of the World Atlas (460 of Part I and 388 of Part II), and 596,513 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$42,928.77, including \$40,782.57 for topographic and geologic maps, \$1,053.80 for geologic folios, and \$1,092.40 for copies of the World Atlas. In addition to this, \$1,341.54 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$44,270.31. The division received and answered 96,688 letters.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS.

During the fiscal year 71 new topographic maps were engraved and printed, and 1 map previously published in photolithographed form was also engraved and printed. A revised edition of 1 topographic map and a photolithographic edition of another were also printed and delivered, making a total of 73 new topographic maps published. In addition to these, 32 new topographic maps were engraved, but the printing was not completed by June 30. Engraving on 15 more new topographic maps was nearly completed. Sixty new maps were photolithographed and printed, making a total of 133 new maps printed and delivered.

Corrections were engraved on the plates of 143 maps. Reprint editions of 196 topographic maps and of 11 corrected State and other photolithographed maps were printed and delivered.

Of new and reprinted maps 340 different editions, amounting to 1,027,585 copies, were delivered to the map room.

One new geologic folio was published, the edition amounting to 3,551 copies. Extra geologic maps of this folio to the number of 700 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING.

A large amount of work was also done for the Government Printing Office, various branches of the War Department, Veterans' Bureau, Federal Board for Vocational Education, Forest Service,

Department of Labor, Interstate Commerce Commission, Bureau of Agricultural Economics, Bureau of Public Roads, Bureau of Standards, Department of Commerce, Office of Public Buildings and Grounds, Bureau of Animal Industry, Post Office Department, Bureau of the Census, Department of State, Coal Commission, Bureau of Lighthouses, Bureau of Plant Industry, Shipping Board, States Relations Service, Weather Bureau, Federal Fuel Distributor, Department of the Interior, Alaskan Engineering Commission, Arlington Memorial Bridge Commission, International Boundary Commission, Federal Power Commission, Brazilian Centennial Exposition, Reclamation Service, Bureau of Mines, National Park Service, General Land Office, Office of Indian Affairs, and Bureau of Foreign and Domestic Commerce. This work for other branches of the Government included many reprint editions and amounted to about \$100,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the Treasury Department.

Transfer impressions to the number of 538 were made during the year, including 194 furnished to contracting printers on requisition of the Government Printing Office, 117 furnished to private firms, 152 furnished under cooperative agreements without charge to various State geological surveys, and 75 furnished to the War Department. The amount turned over to miscellaneous receipts from this work was \$64.50.

During the year a reprint edition of the World Atlas of Commercial Geology (Part I) was completed, as well as a large amount of miscellaneous work relating to the map publications of the Geological Survey.

Of contract and miscellaneous printing of all kinds, 2,944,974 copies were printed. Including topographic maps and geologic folios, a grand total of 3,976,110 copies were printed and delivered. As most of this work was in colors involving many separate printings, it is estimated that the total number of impressions was 20,000,000 or more.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 13,890 negatives (1,597 wet, 491 paper, 2,466 dry, 5,234 field negatives developed, and 4,102 photolithographic), 671 lantern slides, 120,497 prints (91,846 maps and diagrams, 22,775 photographs for illustrations, and 5,876 rectigraphs), 3,552 zinc plates, 204 zinc etchings, 49 celluloid prints, 176 lantern slides colored, and 748 prints mounted.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

The work of the executive division was of the same general character as during the fiscal year 1922.

Mails, files, and records.—During the year 144,467 pieces of mail, of which 2,166 were registered, were opened and referred; besides 5,000 letters and cards were received in connection with revisions of mailing lists. In addition 194,398 letters were received direct by the

ier divisions, making a total of 338,865, an increase of 3 per cent compared with 1922. Of the letters opened in this division, 20,047 retained money remitted in payment for publications of the Survey. The number of ordinary letters mailed through the division was 2,380; of registered letters and packages, 19,374; and of form letters and cards, etc. (addressograph section), 500,000. In addition 1,019 pieces of mail were sent out direct from other divisions. The total number of outgoing pieces of mail for the Geological Survey was 1,412,773.

Freight and express.—During the year 1,667 pieces of freight and express were handled, 896 outgoing and 771 incoming.

Personnel.—At the end of the fiscal year the roll of Secretary's pointees numbered 915, 38 more than at the end of 1922. The total number of changes in the personnel was 481, which included 147 pointments, 109 separations, and 225 miscellaneous changes.

During the calendar year 16,597 days of annual leave and 4,020 days of sick leave were granted, being 77½ per cent of the amount of the annual leave which could have been taken and 18½ per cent of the amount of sick leave which it would have been possible to grant to an average of 716 employees; 10,155 days of leave without pay and furlough were also granted.

The clerical personnel consisted of 27 employees, including the chief; 12 of these were employed in the addressograph section. In addition there were 2 general laborers, a chief messenger, and 10 messengers.

DIVISION OF SCIENTIFIC AND TECHNICAL EQUIPMENT.

The requisitions on the division of scientific and technical equipment numbered 1,186, of which 1,154 were completed. Registration of instruments was checked and errors corrected. The instrument shop has built several pieces of experimental apparatus at a cost 40 to 60 per cent below outside estimates. It has also been successful in working nonmagnetic and noncorrosive steel, having drilled a tube about 260 inches with a ¾-inch bore, a feat that has been considered difficult by outside concerns. This tube has been used to carry a thermometer in measuring deep-well temperatures and shows no signs of corrosion, whereas tubes made of brass and other metals have had to be replaced annually. The instrument shop has done work during the year for the Bureau of Mines and the Reclamation Service. The electrical section inspected all Survey electrical equipment monthly and made general repairs. The carpenter and cabinet maker made and repaired cases for various purposes, special stadia boxes, and other appliances.

Section of field property.—The section of field property serves the entire field force of the Geological Survey. The types of instruments and supplies that have been found by years of successful use to meet the needs of the service are replaced when worn out, and other desirable instruments are added to the general stock. A certain standard of the different supplies is adhered to as far as possible, and a supply of repair parts is kept on hand. Records of camp equipment, livestock, and automobiles are kept. The services of one skilled laborer and one messenger are used for work in preparing

shipments and unpacking instruments sent to Washington. These assistants also make minor repairs. On the return of equipment from the field it is placed in condition for reissue or turned over to the instrument-repair man for attention.

LIBRARY.

The accessions to the library numbered 13,606 books, pamphlets, and periodicals, and 437 maps. Among the purchases were the issues of the Zoological Record for 1906 to 1920, which brought up to date the file of this valuable and expensive work, which is essential for use in paleontology. Cooperation among the Government libraries in Washington continues to lessen duplication. The insertion in the Survey catalog of titles of periodicals and serials available in other libraries is making unnecessary the purchase of many of these for this library. The number of readers and visitors was 13,659, and the loans made for outside use comprised 7,496 books and 356 maps. The library has continued to an increased extent to loan books and to give bibliographic information to specialists in other cities through the system of interlibrary loans and reference. New cards numbering 6,782 were added to the catalog, and 677 catalog entries were sent to the Library of Congress for printing. The correspondence consisted of 2,632 letters received and 2,556 letters sent. Foreign articles and letters to the number of 302 were translated for other divisions of the Survey. The bibliography of North American geology for 1919-20 was published as Bulletin 731. Of Part I of the cumulated bibliography for 1785-1918 (Bulletin 746) 256 galley proofs were read.

DIVISION OF ACCOUNTS.

Condensed statements covering the expenditures from Federal funds during the year are given on pages 87-88. The amounts contributed by States for cooperative work are set forth on pages 29, 52, and 60-61.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1923.^a

Appropriation.	Amount of appropriation.	Funds available.				Expenditures.			Balance.
		Repayments on account of work performed.		For other Geological Survey units.	Total.	Disbursements.	Outstanding liabilities.	Total.	
		For other Government establishments.							
		Made.	To be made.						
Salaries, office of Director.	\$20 760.00		\$2.43		\$20 762.43	\$16,664.93		\$16,664.93	\$4,097.50
Salaries, scientific assistants.	20 000.00				20 000.00	20 000.00		20 000.00	
Topographic surveys.	325 000.00	\$41 038.97	16 917.95	\$12 476.09	394 433.01	399 366.71	\$4 942.12	394 366.83	124.18
Geologic surveys.	300 000.00	6 368.96	2 167.46	197.25	308 673.69	299 163.67	8 332.75	307 496.42	1 177.27
Chemical and physical researches.	40 000.00				40 000.00	39 681.64	243.86	39 925.00	75.09
Preparation of illustrations.	18 260.00	397.43			18 677.43	18 660.80	55.32	18 616.12	61.31
Mineral resources of the United States.	125 000.00	1 598.26	258.33	100.00	126 956.59	125 468.32	526.69	125 995.01	961.58
Mineral resources of Alaska.	75 000.00	4.10	738.68		75 742.78	65 676.56	9 527.77	75 204.33	538.45
Gaging streams, etc.	180 000.00	27 515.78	13 127.32	2 758.45	228 401.55	217 401.92	4 962.21	222 364.13	1 087.42
Books for the library.	2 000.00				2 000.00	1 606.22	381.95	1 991.17	8.83
Geologic maps of the United States.	110 000.00	80 587.00	10 594.55	17 338.99	218 518.54	211 328.48	6 498.69	217 827.17	691.37
Classification of lands.	225 000.00	613.81	25.00	253.15	225 891.96	221 162.51	4 407.36	225 569.87	332.09
	1,450,940.00	158,064.31	42,831.74	33,121.93	\$1,684,957.98	\$1,635,964.76	39,878.22	\$1,675,862.98	9,085.00

^a In addition to these appropriations, \$119,000 for Survey publications was contained in the appropriation for printing and binding but not disbursed by Survey officials. There was also an allotment of \$8,000 for miscellaneous printing and binding from the Interior Department appropriation for that purpose, and an allotment of \$5,000.93 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

^b Included in this amount is \$33,121.93 covering work performed by Survey units for other Survey units; necessarily reported in combining totals but otherwise a duplication.

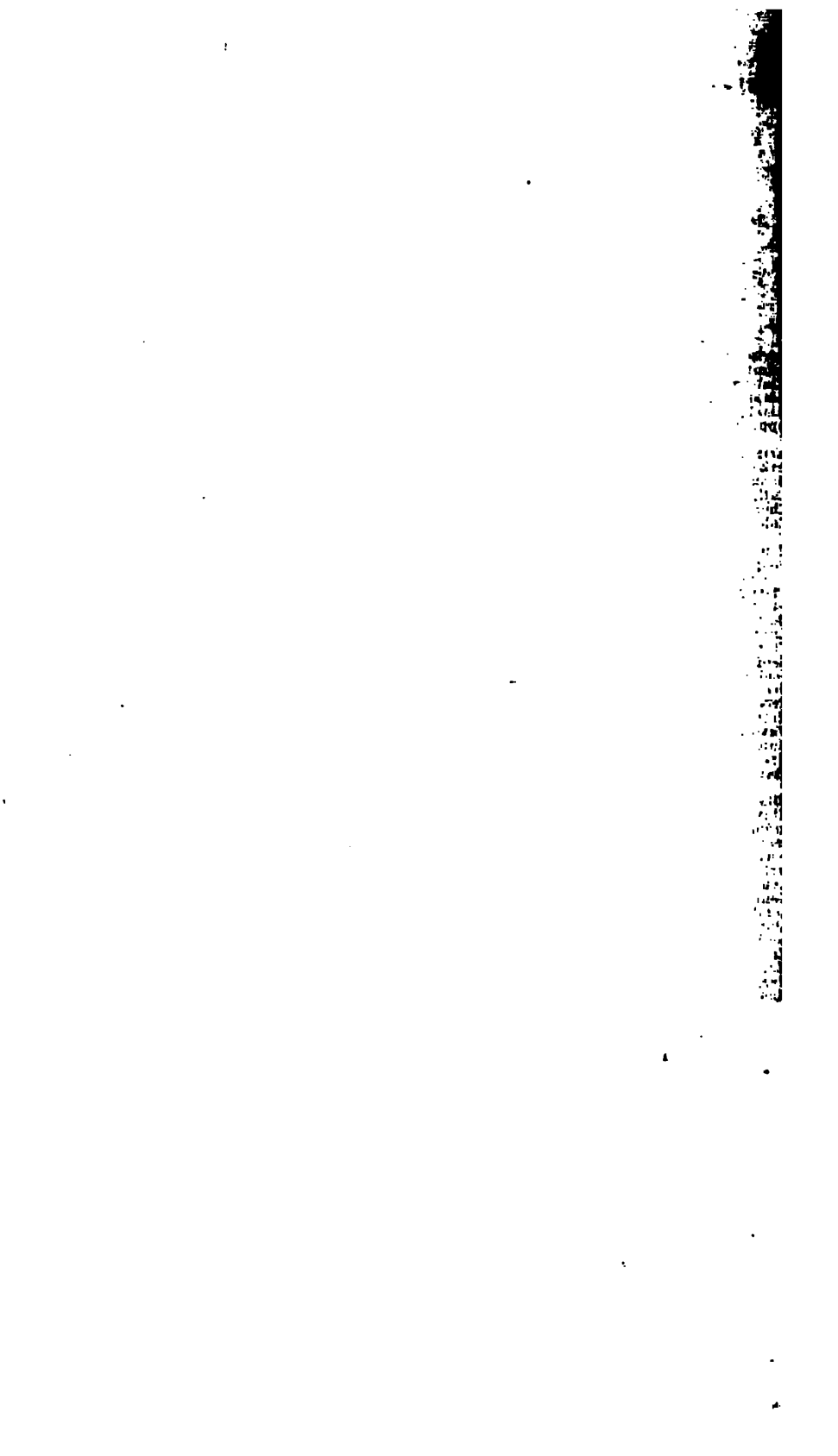
^c Of this total \$9,915.33 is in the hands of special disbursing agents and therefore has not been included in the classification of expenditures, as no vouchers covering disbursement have been received.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1923.

Object of expenditure.	Salaries, office of the director.	Salaries, scientific assistants.	Topo- graphic surveys.	Geologic surveys.	Chemical and physical re- searches.	Prepara- tion of illustra- tions.	Mineral resources of the United States.	Mineral resources of Alaska.	Gaging streams, etc.	Books for the library.	Geologic maps of the United States.	Classifica- tion of lands.	Total.
Personal services.....	\$16,664.93	\$29,900.00	\$277,101.61	\$258,760.80	\$33,204.76	\$18,354.48	\$116,448.41	\$49,464.17	\$173,953.33	.....	\$168,888.18	\$184,191.47	\$1,306,942.16
Stationery and office supplies.....	884.21	956.00	297.13	19.17	247.37	275.33	965.33	.....	31,193.77	.....	35,206.19
Printed forms and letterheads.....	154.55	65.73	.....	.....	157.08	47.90	1,023.93	.....	.....	.....	1,449.19
Scientific and educational supplies.....	421.96	1,264.26	961.05	.....	403.88	150.30	1,876.02	.....	1,917.90	142.34	7,120.71
Sundry supplies.....	1,995.02	677.12	109.00	67.90	34.67	190.57	2,261.53	.....	5,477.57	303.17	10,136.55
Materials.....	630.82	7.63	.....	.....	.....	.....	115.14	.....	.....	7.00	760.59
Subsistence and care of animals, and storage and care of vehicles.	1,628.66	1,218.11	15.00	.....	41.18	109.51	109.51	.....	.....	284.94	3,295.40
Telephone service.....	645.33	181.46	2.85	.....	1,221.53	125.74	401.75	.....	5.49	167.54	2,789.69
Other communication service.....	30.25	30.45	1.20	.....	179.89	2.60	507.29	.....	.....	70.23	821.91
Travel expenses.....	1.70	.....	.....	.....	70.00	1.68	13.00	.....	.....	4.70	72.38
Hire, maintenance, operation, and repair of horse-drawn and pas- senger-carrying vehicles.....	58,509.08	18,511.24	2,268.75	.....	4,068.31	12,068.00	14,833.14	.....	289.74	29,268.28	139,814.60
Transportation of things.....	8,730.29	2,299.53	286.43	.....	171.84	46.00	2,603.54	.....	.....	3,153.27	17,260.90
Printing and binding.....	11,787.78	3,245.51	569.50	.41	156.97	435.95	3,880.21	.....	19.73	7,814.95	27,914.01
Lithographing, engraving, and engrossing.....	23.00	.....	.....	.....	2.00	.....	18.25	.....	.....	2.40	45.65
Stenographic work, typewriting and duplicating work, etc. (Job work).....	5,854.75	982.98	8.40	14.14	207.18	116.04	663.14	.....	3.00	321.98	8,151.61
Photographing and making photographs and prints.....	10.55	150.82	12.38	.....	1.20	.....	15.50	.....	.....	50.00	240.45
Reprints.....	3,717.56	3,138.69	61.10	160.02	188.27	325.76	1,001.02	.....	98.87	1,186.45	9,877.74
Repairs and alterations.....	1,896.21	1,555.46	767.66	.....	123.34	86.01	1,138.22	.....	3,771.74	182.32	2,246.56
Special and miscellaneous current expenses.....	5,788.00	7,784.69	376.79	.....	1,581.68	1,313.92	1,049.55	.....	786.39	2,752.54	21,434.47
Purchase of passenger-carrying vehicles.....	1,527.97	1,004.80	.....	.....	.....	.....	4,159.40	.....	.....	2,865.00	9,562.17
Furniture, furnishings, and fix- tures.....	668.86	378.64	.50	.....	133.50	1,208.98	313.71	.....	318.00	708.36	3,765.55
Educational and scientific equip- ment.....	137.77	1,726.74	909.97	.....	32.60	248.33	4,713.11	.....	1,038.35	134.28	10,961.72
Livestock.....	500.00	.....	.....	.....	.....	2,263.00	2,263.00
Other equipment.....	9,442.27	2,447.86	17.60	.....	691.01	728.09	2,708.66	.....	4,018.58	8,960.77	29,932.71
Structures.....	2,940.66	.....	.....	.....	2,940.66
	16,664.93	29,900.00	362,268.50	307,466.42	39,926.00	18,616.12	125,966.01	67,329.33	222,364.13	1,991.17	217,627.17	225,696.87	1,606,947.65

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U. S. DEPARTMENT OF THE INTERIOR

**FORTY-FIFTH ANNUAL REPORT OF THE
DIRECTOR OF THE GEOLOGICAL SURVEY
TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1924**



DEPARTMENT OF THE INTERIOR

HUBERT WORK, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

FORTY-FIFTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES
GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR

ENDED JUNE 30

1924



WASHINGTON

GOVERNMENT PRINTING OFFICE

1924

Directors of the U. S. Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907

GEORGE OTIS SMITH, 1907-

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PLATE I. Areas covered by topographic surveys made by United States Geological Survey prior to July 1, 1923.....

FORTY-FIFTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, *Director*

APPROPRIATIONS

The appropriations made directly for the work of the Geological Survey for the fiscal year 1924 included 11 items, amounting to \$1,670,190. In addition \$110,000, to be disbursed under the direction of the Public Printer, was appropriated for printing the reports of the Survey and allotments of \$10,000 for miscellaneous printing and binding and of \$4,280 for miscellaneous supplies were made to the Survey from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of this report.

COOPERATION

Cooperation with States was continued in general accordance with the plans followed for many years. Thirty-six States thus shared in the cost of the geologic, topographic, and hydrologic work of the Survey. This form of cooperation is not only of mutual pecuniary advantage to State and Nation but serves to maintain that relation between the two which is the ideal of American government. Counties and municipalities also participated in this cooperative work. The total amount expended in such cooperative work during the year was \$600,000. Cooperation was also continued with other bureaus of the Government service. Funds aggregating \$184,720 were placed to the credit of the Geological Survey for work done by it for other Government bureaus and offices.

GENERAL SUMMARY OF THE WORK OF THE YEAR.

The work of the Geological Survey during the fiscal year 1924 is set forth in detail in this report in the statements of work done by its several branches. A brief itemized summary of the principal features of the work is given below.

WORK IN GEOLOGY

Made geologic surveys in 44 States and in Alaska, the work done including geologic mapping, determinations of stratigraphy, structure, and geologic history, and examinations of mineral resources.

Made studies in 8 States to determine the prospects of obtaining oil or gas, and prepared reports showing the results of the studies.

Continued laboratory work to discover the sources of petroleum and the mode of its formation and the features of oil sands—such as texture and porosity—that are favorable to the accumulation of petroleum.

Made researches in the field and the laboratory to determine the mode of formation of oil shale.

Continued to assist the United States Coal Commission by furnishing facts concerning the coal regions.

Continued cooperation with the General Land Office, the Indian Office, and the Forest Service in the examination and classification of public lands, the work being done especially to determine whether they contain oil, gas, or other mineral deposits.

Examined coal fields in 6 States, prepared 8 reports (4 for publication elsewhere), and published 3 reports and 4 press notices on fields examined.

Made cooperative field studies of ore deposits, coal beds, and geologic formations with 12 States.

Made special studies of metalliferous deposits in Michigan and California with a view to the broader application of the results.

Continued the search for deposits of potash and found deposits in southwestern Texas that promise to be of commercial value.

Made field investigations to determine resources of arsenic in Western States.

Made geologic examinations of sites for dams and reservoirs in Western States in cooperation with the Bureau of Reclamation, to determine the strength, imperviousness, and other features of the rocks.

Completed cooperative field work on a geologic map of Arizona, to be published by the State, and completed office work on a geologic map of Wyoming, now in preparation for publication.

Aided in completing and publishing a report on the geology of Haiti, the cost of which was borne by the Haitian Government.

Identified thousands of fossils sent in from different parts of the United States and from the West Indies and Central and South America, for stratigraphic determination and correlation, principally as a means of discovering the geologic horizons at which oil may be found.

Continued to study the San Andreas earthquake rift in California in cooperation with the Seismological Society of America, the Carnegie Institution, and the Coast and Geodetic Survey.

Published 30 reports on the geologic features and mineral resources of areas in different parts of the United States.

WORK ON MINERAL RESOURCES

Collected and published statistics of mineral production and cooperated in this work with 16 States and the Bureau of the Census.

Assisted the United States Coal Commission to the date of its termination, maintained contact with the Department of Commerce in its studies of special features of the coal industry, and made and reported on four canvasses of consumers' stocks of coal in cooperation with the Bureau of the Census.

Issued weekly reports showing the production of coal, prepared and published monthly statements on the production of petroleum, and compiled for the Federal Trade Commission special statistical reports on petroleum.

Prepared a map showing petroleum and natural-gas fields and petroleum pipe lines in Texas.

Continued the compilation of data showing mineral production in foreign countries and the world's fuel reserves.

WORK IN CHEMISTRY AND PHYSICS

Made 782 quantitative analyses of rocks and minerals and identified 2,000 mineral specimens.

Made laboratory studies to determine the mode of formation of metallic copper in ore deposits.

Made studies of the chemical nature of the organic matter in oil shale in order to discover the mode of formation of petroleum and other natural hydrocarbons.

Made a series of assays for determining the presence of small quantities of platinum in rocks.

Made 632 analyses of potash salts in material from Texas, disclosing promising potash-rich beds.

Measured deep earth temperatures and temperatures of hot springs in a study of the temperatures at depths in the earth's crust.

Made laboratory studies of the texture, pore space, and productivity of oil sands.

WORK IN ALASKA

Continued the survey of Naval Petroleum Reserve No. 4, traversing areas aggregating 220 linear miles along six rivers and exploring the lower part of Wainwright Inlet, mapping 2,150 square miles in northern Alaska.

Made reconnaissance geologic surveys elsewhere in Alaska covering 8,570 square miles and reconnaissance topographic surveys covering 4,300 square miles.

Continued the study of the copper deposits of Prince William Sound and of the geology and mineral resources of southeastern Alaska, especially the Hyder district, and of the nickel deposits in the Sitka district.

Continued the study of the stratigraphy of Alaska Peninsula, especially the Cold Bay petroleum field and the Chignik district.

Completed a report on the Mesozoic geology of Alaska.

Continued an examination of the ore deposits and other mineral resources in the region along the Alaska Railroad and prepared and published a report (Bulletin 755-C) giving its results.

Completed a study of the Tertiary flora of Alaska and assembled the results in form for early publication.

Revised for republication the geographic dictionary of Alaska.

Published a report on work done in Alaska in 1921, three chapters of a similar report on work done in 1922, and a bulletin on the Ruby-Kuskokwim region.

Published a large relief map of Alaska in which the topographic features are brought out by brown shading and the water features are shown in blue.

TOPOGRAPHIC WORK

Surveyed for mapping 16,021 square miles in the United States, resurveyed 64 square miles, and made river profile surveys covering 818 linear miles, running in connection with these surveys 7,781 linear miles of primary levels and setting 2,059 permanent bench marks.

Occupied 177 triangulation stations, of which 122 were permanently marked.

Ran primary traverse lines aggregating 5,832 miles and in connection therewith set 1,450 permanent marks.

Completed 696 square miles of topographic surveys in Hawaii, the work including the running of 228 miles of primary levels and the establishment of 90 bench marks.

Compiled for the air service of the United States Army air-route maps of more than 100,000 square miles of territory.

Prepared maps of proposed dam sites on Colorado River and a map of Arizona showing their location.

Assembled and redrafted reconnaissance maps of streams in Colorado and Wyoming and made a series of maps of Missouri River.

Continued cooperation in topographic surveys with 19 States and with Hawaii and performed base-map work for the National Park Service, the United States Coal Commission, the General Land Office, and the Federal Board for Vocational Education.

Published editions of 70 new topographic maps that form sheets of the Topographic Atlas of the United States (including shaded relief editions of standard maps), maps of Alabama and Arizona, a shaded relief map of Kentucky, and photolithographic editions of 92 new maps (to be engraved later), 34 maps not yet scheduled for engraving, and of 17 river plans and profiles.

Published a bulletin (No. 709) giving in one volume the results of triangulation in the United States in 1916-1918.

Published a bulletin (No. 689) describing the boundaries, areas, geographic centers, and altitudes of the United States and the several States.

WORK ON WATER RESOURCES

Continued stream gaging at more than 1,600 stations on rivers in 41 States and in Hawaii to determine the quantities of water available for irrigation, power, and other uses, performing part of the work in cooperation with 29

States and Hawaii and with the Bureau of Reclamation, Forest Service, National Park Service, Office of Indian Affairs, Federal Power Commission, Office of the Chief of Engineers, and city of San Francisco.

Made investigations of ground water in 16 States, cooperating in this work in certain areas with 5 States, the Bureau of Reclamation, and the General Land Office.

Analyzed 819 samples of water and made studies to improve methods of water analysis.

Prepared monthly reports on the production of electricity and the consumption of fuel by public-utility power plants and on the stocks of coal on hand at such plants and a report on the developed water power of the United States.

Made surveys of all promising dam sites along Colorado River from Lees Ferry to the lower end of Black Canyon and began the preparation of a report showing the results of the work done.

Made examinations of power sites, proposed power developments, the power-value of streams and lands, and the use of water for power and irrigation in 8 States, these examinations including several items of work done for the Federal Power Commission.

Continued examinations of public lands for classification under the enlarged and stock-raising homestead laws, performing such work in 18 States and covering areas embraced in about 2,000 applications.

WORK IN CLASSIFICATION OF PUBLIC LANDS

Classified 1,812,685 acres of public land as coal land and 4,105 acres as oil land and made other classifications involving a net decrease of 2,998,210 acres in areas withdrawn as possible coal land and of 421,723 acres in areas withdrawn as possible oil land.

Reported on 14,782 cases arising under the administration of the public-land laws.

Reported on 6,282 applications made for permits, leases, or patents under the mineral-land laws.

Recommended the addition of 153,052 acres to the power-site reserves and the elimination of 58,537 acres.

Increased the area withdrawn under the Nevada ground-water reclamation act from 1,300,940 acres to 1,425,060 acres.

Recommended designations involving 1,370,449 acres of land available for settlement under the enlarged-homestead acts and the cancellation of designations involving 12,379 acres.

Recommended the addition of 107,384 acres to the public water reserves and the elimination of 6,783 acres.

Recommended the designation of 1,801,441 acres as stock-raising homestead land and the cancellation of designations covering 760 acres.

WORK IN PRINTING AND PUBLICATION

Edited and otherwise prepared for printing 27,981 pages of manuscript, read and corrected 2,306 galley proofs and 15,928 page proofs, and prepared indexes for 25 reports covering 4,455 pages.

Prepared for reproduction in reports 4,442 illustrations.

Edited for engraving 90 new topographic maps, edited for reprint 222 topographic maps, edited 54 plan and profile river survey sheets for photolithographic reproduction, edited 249 maps for incorporation in Survey reports, and read proofs of 613 maps.

Published 114 reports containing 14,543 pages in editions amounting to 351,107 copies, 4 geologic folios in editions amounting to 15,485 copies, and 92 new or revised topographic maps and 203 reprinted maps in editions amounting to 1,330,173 copies.

Distributed 521,548 books and pamphlets, 16,681 geologic folios, 923 copies of the World Atlas of Commercial Geology, and 735,573 maps, a total of 1,274,725 publications, of which 617,391 were sold.

Engraved and printed 70 new maps and completed the engraving for 32 new maps, photolithographed and printed 92 new maps, made corrections on the engraved plates for 214 maps, and reprinted editions of 193 maps and of 10 corrected State and other photolithographed maps.

Printed for other branches of the Government or for incorporation in reports in the Geological Survey 4,635,962 copies of maps, plans, sections, etc., the work involving more than 23,000,000 impressions.

OTHER WORK

Maintained a photographic laboratory, making an output of 11,270 negatives, 1,800 lantern slides, 111,037 prints, and other material.

Maintained a geologic library, receiving 14,655 books, pamphlets, periodicals, and maps, affording facilities for 12,908 readers, and lending for use outside of the library 7,054 books and maps.

Received 348,361 letters and other pieces of mail, sent out 883,179 pieces, and handled 3,505 pieces of freight and express outgoing and incoming.

SPECIAL FEATURES

To catalog the activities or even the accomplishments of the year is not enough: special mention needs to be made of a few outstanding items in the record. To stress these may serve both to set forth the nature of the public service rendered by this scientific bureau and to link up its present-day activities with what had been done earlier.

The Colorado Canyon expedition, which attracted some public attention, well exemplifies the success won by uniting specially trained topographic, hydraulic, and geologic engineers in a carefully planned and skillfully executed effort. This traverse of the Grand Canyon completed the instrumental surveys of Colorado River that had been begun 12 years before at Kremmling, in northern Colorado. The mapping of 253 miles of canyons and the examination of 22 possible dam sites during the year was a task fraught with danger, but the Government engineers regarded the danger as only "in the day's work" of scientific exploration. Colonel Birdseye and his associates carried on the traditions of the field service, for the second Director, Major Powell, had made the first boat trip through the Grand Canyon in 1869. This thorough survey of the Colorado and its principal tributaries is the necessary preliminary to the making of Federal and State plans for the full utilization of the natural resources in a region where water gives value to land.

Equally noteworthy and equally spectacular are the exploratory expeditions into Arctic Alaska, the first made in the summer of 1923 and the second started in the following winter. This geologic examination of the naval petroleum reserve in northern Alaska has been undertaken at the request of the Secretary of the Navy to determine the possibility of finding oil in quantities sufficient to add materially to the reserves for the future use of the Navy, if not indeed large enough to augment the Nation's supply for other needs. The first season's examination along the Arctic coast of Alaska verified the reports of large seepages of oil and of geologic conditions sufficiently favorable to oil accumulation to warrant the second expedition, which started northward with dog sledges from the Yukon in February last and had crossed the Endicott Range by March. The area to be traversed and mapped by the three parties of this expedition is roughly 3,700 square miles and includes the largest tract of unexplored United States territory. Dr. Philip S. Smith is the geologist in charge of this exploration, and his plans for it were made 13 years before, when he was working on the southern margin of the area.

This search for an oil field in Arctic Alaska illustrates the emphasis now put on geologic work in the exploitation of fuel resources, but

the nature of the exploration and the experienced personnel available for it fittingly mark the status of the Geological Survey's work in Alaska after 25 years of uninterrupted effort. In the quarter of a century since 1898 slightly more than \$2,000,000 has been appropriated for the investigation of the mineral resources of Alaska, and by this means over one-fifth of the area of the Territory has been covered by reconnaissance geologic surveys and more than one-quarter of the area by reconnaissance topographic surveys. Exploratory surveys over many thousands of square miles and visits to hundreds of mining camps, large and small; maintenance of scores of stream-gaging stations; and the publication of 420 maps and 383 reports are other items in the systematic scientific investigations carried on in this outlying territory—the whole making up a record of consistent promotion of Alaskan interests in which the Department of the Interior may take justifiable pride. Since July, 1903, Alfred H. Brooks has been in active charge of the work, and he has become the recognized authority on the geography, geology, and resources of Alaska, but the credit for what has been accomplished he would wish to divide among his associates, some 120 geologists and engineers who have shared in this pioneering work.

The Director's service as a member of the United States Coal Commission ended on September 22, and he resumed his duties with the Survey on September 24. This connection of the Survey with the special investigation assigned to the commission was the logical outcome of the particular attention given to the country's resources in coal ever since the Geological Survey undertook the technical supervision of the statistical study of the coal industry for the census of 1880, and especially since the general review of the coal fields made 20 years later and fully summarized in Part III of the Twenty-second Annual Report. The geologic and economic studies of the coal resources of the country to an increasing extent engaged the attention of Federal geologists and statisticians until the Geological Survey had become the largest single repository of facts relating to the coal industry, and of this accumulation the Coal Commission made full use.

Similarly, the appointment, in March, of the Director as a member of the President's Naval Oil Commission was a recognition of the leading part played by the Survey in the geologic and economic study of the oil resources of the country, and especially in the development of the national policy of conservation through leasing publicly owned oil land and setting aside reserves for naval purposes. Again the accumulated information and the trained geologists of the Survey were thus made available, to assist the commission in determining the policy and procedure to be recommended to the President.

Still another item may be mentioned as linking present with past work. In April, 1924, the Survey published a "shorter contribution" by Dr. F. W. Clarke entitled "The evolution and disintegration of matter." More than 50 years ago Doctor Clarke attacked the same subject in a paper on evolution and the spectroscope, and his recent contribution may be regarded as a by-product of this senior chemist's long service in geochemical research—a contribution not unconnected with his service for many years as chairman of the International Committee on Atomic Weights. Further evidence of the value of

Doctor Clarke's contribution to geologic and chemical science is found in his completion this year of the manuscript for a fifth, revised and enlarged edition of the Data of Geochemistry, which was first published in 1908.

WORK BY THE DIRECTOR

The Director resumed his administrative duties in the Survey on September 24, immediately after the legal termination of the existence of the Coal Commission, on which he had served. His year's absence had in no wise interrupted nor retarded the progress of the work; indeed, notable advances had been made in the effectiveness of this branch of the public service.

On March 25 the President appointed the Director as one of three members of a commission to study matters pertaining to the naval oil reserves, and on the organization of the commission he was selected to act as chairman. His service on this informal investigating body did not conflict with his regular duties or involve his absence from Washington, except for a visit in May to the naval oil reserves in California and Wyoming.

Late in June the Director attended the first World Power Conference in London as the personal representative of the Secretary of the Interior. At one of the opening general sessions he served as chairman, the subject under discussion being a national review of power resources.

Some of the points of contact between the Survey's scientific and engineering investigations and the public are indicated in the following titles of addresses given by the Director during the year:

- October 16, "Lessons from the Coal Commission's work," American Institute of Mining and Metallurgical Engineers, Boston section.
- November 20, "The recommendations of the United States Coal Commission," Academy of Political Science, New York.
- December 5, "Relations of the Geological Survey to chemical engineering," American Institute of Chemical Engineers, Washington.
- December 17, "Engineering outlook on the coal problem," American Institute of Mining and Metallurgical Engineers, Washington section.
- December 28, "Fluctuations in mineral output," American Statistical Association, Washington.
- January 17, "Coal a national issue," Washington Academy of Science.
- February 5, "Foundations of industry," Providence Engineering Society.
- February 26, "New England's interest in power," Economic Club, Worcester, Mass.
- March 8, "Why superpower?," Economic Club, Portland, Maine.
- March 20, "Industrial relations in the coal industry," New Jersey Chamber of Commerce, Newark.
- April 1, "Conservation as applied to coal," Lafayette College, Easton, Pa.
- April 7, "Coal and law," Federal Law Association, Washington.
- May 22, "Planning for power," Massachusetts State Chamber of Commerce, Worcester.

Less formal addresses on the subject of coal were given before the Rotary Club of Skowhegan, Maine; the students at Colby College; the students at Lehigh University; the Women's City Club, Washington; the Thursday Evening Club, Bethlehem, Pa.; the Conservation Society, York, Pa.; the National Industrial Conference Board, New York; and the Delta Kappa Epsilon Association, Washington.

Most of these addresses were printed in technical journals or in proceedings of the societies.

Supplementing their testimony before the Senate and House committees on agriculture, the Director and Mr. Mansfield prepared an article, "Potash—the key to prosperous agriculture," for publication in the May number of the American Bankers' Association Journal.

PUBLICATIONS

The publications of the year consisted of 114 books and pamphlets of the regular series, 104 new or revised maps, 203 reprinted maps, and numerous circulars, inquiry forms, lists of publications, etc. The total number of pages in the new book publications was 14,553.

Brief notices of the publications in the regular series and of the new maps are given below.

FORTY-FOURTH ANNUAL REPORT of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1923. 91 pp., 1 pl. (map).

A detailed account of the work of the Geological Survey during the year.

PROFESSIONAL PAPER 126. Geology of the Coastal Plain of Texas west of Brazos River, by Alexander Deussen. 151 pp., 36 pls. (incl. 2 maps), 88 figs.

Sets forth the results of a geologic investigation of an area of about 38,000 square miles extending from Brazos River southwestward nearly to the Rio Grande.

PROFESSIONAL PAPER 131. Shorter contributions to general geology, 1922; David White, chief geologist. 216 pp., 50 pls. (incl. 1 map), 12 figs.

A consolidation of papers published separately in advance. Includes papers on paleontology, stratigraphy, and physiography, covering areas in New England, the Southeastern States, Texas, Colorado, Wyoming, and Arizona.

PROFESSIONAL PAPER 132-A. Rock formations in the Colorado Plateau of southeastern Utah and northern Arizona, by C. R. Longwell, H. D. Miser, R. C. Moore, Kirk Bryan, and Sidney Paige. 25 pp., 10 pls., 1 fig.

Report on the rock formations within the area to be flooded by a proposed storage reservoir to be created by the construction of a large dam on Colorado River at Lees Ferry, Ariz. Covers the geology of the canyons of Colorado and San Juan rivers and the lower parts of tributary canyons.

PROFESSIONAL PAPER 132-B. A new fauna from the Colorado group of southern Montana, by J. B. Reeside, jr. 11 pp., 11 pls.

Describes a small but interesting fauna recently collected in the Crow Indian Reservation, Big Horn County.

PROFESSIONAL PAPER 132-C. Notes on the geology of Green River valley between Green River, Wyo., and Green River, Utah, by J. B. Reeside, jr. 18 pp., 6 figs.

Presents notes on geologic features observed during an expedition to gather data needed to complete a study of the power resources of Green River.

PROFESSIONAL PAPER 132-D. The evolution and disintegration of matter, by F. W. Clarke. 38 pp., 1 pl.

The discovery of the "periodic law" led to the conclusion that the so-called chemical elements must have had some community of origin. The suggestion was first published by Doctor Clarke more than 50 years ago that the evolution of planets from nebulae was accompanied by an evolution of the chemical elements. The discovery of radioactivity led to the further discovery that the elements can decay. In the appearance of the so-called "new" stars we probably see a reversal of the evolutionary process and a return to a nebular condition. In this paper Doctor Clarke summarizes the researches that have led to these conclusions and explains the processes involved.

PROFESSIONAL PAPER 132-E. An early Eocene florule from central Texas, by E. W. Berry. 8 pp., 1 pl.

Describes a small collection of fossil plants including ten species, obtained near Sayersville, Bastrop County, Tex.

PROFESSIONAL PAPER 133. The correlation of the Vicksburg group, by C. W. Cooke, and The Foraminifera of the Vicksburg group, by J. A. Cushman. 73 pp., 8 pls., 1 insert.

Mr. Cooke's paper sets forth the results of recent investigations on the Oligocene formations of the Southeastern States and corrects certain errors in the standard correlation tables. Mr. Cushman describes the numerous species of Foraminifera found in the formations of the Vicksburg group and figures many of them. The paper contains a table showing the distribution of the species described.

BULLETIN 689. Boundaries, areas, geographic centers, and altitudes of the United States and the several States, with a brief record of important changes in their territory, by E. M. Douglas. 240 pp., 7 pls. (incl. 4 maps), 22 figs.

A revision of Bulletin 226, published in 1904, with much new matter concerning boundaries and related subjects. Contains a large amount of interesting detailed information on the history of the several boundaries, numerous quotations from treaties, acts, and other documents, reproductions of ancient maps, and diagrams showing successive changes in boundaries.

BULLETIN 700. Triangulation and primary traverse, 1916-1918: C. H. Birdseye, chief topographic engineer. 920 pp., 2 pls. (incl. 1 map).

Gives computed results of the field work of primary control by the Geological Survey. The matter had been published in separate chapters, each covering a State or a group of States.

BULLETIN 718. Geology and ore deposits of the Creede district, Colo., by W. H. Emmons and E. S. Larsen. 208 pp., 12 pls. (incl. 3 maps), 32 figs., 1 insert (table of geologic formations).

Ore deposits were discovered near the site of Creede, in Mineral County, Colo., in 1883, and the finding of rich ore on several claims in 1891 stimulated a boom that rivaled anything in the earlier history of western mining camps. In the four decades since the first discovery the district has produced over \$40,000,000 in gold, silver, copper, lead, and zinc. This district is a part of the San Juan Mountains.

BULLETIN 723. Geology and ore deposits of the Manhattan district, Nev., by H. G. Ferguson. 173 pp., 18 pls. (incl. 5 maps), 15 figs.

Gold was discovered in the Manhattan district in 1905. The greatest production was reached in 1911, and since then mining has declined. This report describes the geology of the district. The author concludes that the lode deposits belong to two periods of metallization—one early Cretaceous and one late Tertiary—and that much of the rich ore mined in the early days of the camp was produced by downward enrichment. Placer gold has been found in the gravel of Manhattan Gulch. The district has probably passed its most productive stage, though many more small ore bodies may still be found.

BULLETIN 735. Contributions to economic geology (short papers and preliminary reports), 1922, Part I, Metals and nonmetals except fuels: F. L. Ransome, G. R. Mansfield, and E. F. Burchard, geologists in charge. 346 pp., 15 pls. (incl. 4 maps), 67 figs.

The papers in this volume have been published separately, most of them in 1922. The principal subjects considered are silver ores in Nevada, Colorado, and Arizona, iron ores in North Carolina and Tennessee, and peridotite in Arkansas.

BULLETIN 736. Contributions to economic geology (short papers and preliminary reports), 1922, Part II, Mineral fuels: K. C. Heald, geologist in charge. 290 pp., 24 pls. (incl. 11 maps), 12 figs., 1 insert.

Contains eight papers, previously published in separate form, on oil or gas in Oklahoma, Texas, Montana, Wyoming, and Arkansas.

BULLETIN 739. Mineral resources of Alaska: report on progress of investigations in 1921, by A. H. Brooks and others. 190 pp., 3 pls. (maps), 8 figs.

The eighteenth of a series of annual bulletins summarizing the results of work done by the Geological Survey in Alaska. Contains papers on the Alaska mining industry in 1921, the Wrangell, Cold Bay, Iniskin Bay, and Anchorage districts, and metalliferous deposits in the Yukon and Kuskokwim regions.

BULLETIN 744. The lime belt of Massachusetts and parts of eastern New York and western Connecticut, by T. N. Dale. 77 pp., 8 pls. (incl. 4 maps), 23 figs.

The lime-producing belt of western Massachusetts and adjacent States contains both calcitic and dolomitic limestones, and as each of these varieties has properties that specially fit it for certain uses a geologic map showing their boundaries is of economic value. This report gives the results of a field study in which these boundaries were traced, describing the areal distribution and characteristic properties of the limestones and the salient features of the quarries that have been opened in them and presenting other pertinent information.

BULLETIN 746. Geologic literature on North America, 1785-1918, by J. M. Nickles. Part I, Bibliography, 1160 pp.

BULLETIN 747. Geologic literature on North America, 1785-1918, by J. M. Nickles. Part II, Index, 680 pp.

Bulletin 746 is a cumulation of the series of bibliographies of North American geology issued by the United States Geological Survey as 16 separate bulletins, with the addition of many titles not previously listed. The papers of each author are listed in chronologic order by years, and with each title is given the information needed in finding the paper in a library. Bulletin 747 is an index to the publications listed in Bulletin 746. These books are an essential part of the equipment of every geologist.

BULLETIN 748. The Twentymile Park district of the Yampa coal field, Routt County, Colo., by M. R. Campbell. 86 pp., 13 pls. (incl. 1 map).

The commercial development of the Yampa coal field was begun in 1906, when the "Moffat railroad" reached its eastern border. Operations have been undertaken in several parts of the field, but there has been a dearth of reliable information as to the correlation of the coal beds and the relative value of the coal mined at different places. This report has been written to supply such information for an important part of the larger field. It describes the geology and gives analyses of the coals and comparisons of their heating value.

BULLETIN 749. Geology of the Tullock Creek coal field, Rosebud and Big Horn Counties, Mont., by G. S. Rogers and Wallace Lee. 187 pp., 10 pls. (incl. 5 maps), 5 figs.

The Tullock Creek coal field includes 900 square miles in the angle formed by the junction of Big Horn River with the Yellowstone, about halfway between Miles City and Billings. It consists of the lands east of the Big Horn ceded to the Government by the Crow Indians in 1904. The coal is subbituminous and compares favorably with the commercial varieties now sold in neighboring markets. This report gives full information concerning the beds considered workable at present. About 20 per cent of the field has been classified as coal land.

BULLETIN 750-A. Iscmaninite at Ouray, Utah, by F. L. Hess. 18 pp., 2 pls., 1 fig.

Describes a water-soluble molybdenum-bearing mineral found in sandstone of Eocene age and gives a brief review of the few known occurrences of iscmaninite elsewhere in the world.

BULLETIN 750-B. Origin of certain rich silver ores near Chloride and Kingman, Ariz., by E. S. Bastin. 25 pp., 11 figs.

One of the papers giving the results of Mr. Bastin's general study of silver enrichment in many parts of the Western States. Although some of the richest silver ores of the area, now exhausted, were the products of downward enrichment, the rich ruby silver ores are in the main primary and may be expected to continue to greater depths than the enriched ores.

BULLETIN 751-B. Progress report on a subsurface study of the Pershing oil and gas field, Osage County, Okla., by W. W. Rubey. 52 pp., 3 pls. (incl. 2 maps), 9 figs.

A preliminary statement of the results of an intensive study of the Pershing field, which lies in the east-central part of Osage County a few miles southeast of Pawhuska.

BULLETIN 752. Coal resources of the Raton coal field, Colfax County, N. Mex., by W. T. Lee. 260 pp., 22 pls. (incl. 2 maps), 18 figs.

The Raton coal field is a small part of a great region of coal-bearing rocks in Colorado and New Mexico, which extends about 90 miles from north to south and 30 miles from east to west and includes also the Trinidad coal field of Colorado. The coal of this region compares favorably with the best bituminous coal of Ohio and some other fields. Much of it will coke, and at many places it occurs in thick beds that are easily mined. During the 10 years ending in 1920 this region yielded more than 27,000,000 tons of coal. The Raton field contains a large quantity of coal in beds of great commercial value, but the geologic conditions are so diverse that careful prospecting is necessary to determine a good location for a mine. This paper gives geologic information concerning the field, paying special attention to geologic structure, relation of the coal outcrops to slopes, canyons, and other features as bearing on ease of transportation, quality of the coal, and methods of mining.

BULLETIN 754. The Ruby-Kuskokwim region, Alaska, by J. B. Mertie, jr., and G. L. Harrington. 137 pp., 9 pls. (incl. 4 maps), 2 figs.

The region described lies in west central Alaska and includes three of the more productive placer districts of the Yukon Valley--Iditarod, Ruby, and Imoko--also the Candle Creek district, the most productive placer camp in the Kuskokwim Valley. The total value of the gold and silver produced in these districts to the end of 1922 was over \$27,500,000. The camps in this region have been described separately in previous reports, most of which are now either out of stock or out of date. The present volume is a summary report on the whole region and includes much geologic information not previously published.

BULLETIN 755-A. The Alaskan mining industry in 1922, by A. H. Brooks and S. R. Capps. 72 pp.

The first chapter of the nineteenth annual bulletin on the mineral resources of Alaska. Shows that the value of the total mineral production in 1922 was \$2,500,000 greater than in 1921. Expresses the conviction that in spite of rather widespread pessimism the Alaskan mining industry is now on a more substantial basis than ever before and is advancing, not retrograding. Gives statistics covering several years for all the principal mining districts and contains a list of recent Survey publications on Alaska.

BULLETIN 755-B. The metalliferous deposits of Chitina Valley, Alaska, by F. H. Moffit. 18 pp.

Summarizes the mode of occurrence of the valuable minerals so far discovered in Chitina Valley and points out their relation to the geologic formations and structure. Copper is the chief metal mined commercially, but gold and silver have also been produced.

BULLETIN 755-C. Geology and mineral resources of the region traversed by the Alaska Railroad, by S. R. Capps. 82 pp., 7 pls., 1 fig.

The Government railroad between Seward and Fairbanks, Alaska, completed in March, 1923, has profoundly affected the welfare of a large region, providing, for example, a comfortable journey of a few hours in place of weeks of severe physical exertion over a trailless country. The effects of the stimulus of better transportation are already evident, but the railroad has been in operation too short a time to do more than start the intensive development of the country, and the population now served by the railroad is no index of the number of people this region may some time support. In the development that is to come an inventory of the resources of the region will be of great assistance, and this bulletin supplies such information for the mineral industry. The railroad also provides an easy summer tourist trip that includes a great variety of scenery, and the notes on the geography of the region given in this bulletin will be of interest to the prospective traveler.

BULLETIN 760-A. Pedestal rocks in the arid Southwest, by Kirk Bryan. 13 pp., 5 pls.

One of the "Contributions to the geography of the United States." Considers the causes that produce the peculiar forms sometimes called "hoodoos" or "mushrooms," and concludes from a study of some of these rocks in Arizona and New Mexico that even in an arid region water erosion as well as wind scour may contribute to their formation.

WATER-SUPPLY PAPER 489. The occurrence of ground water in the United States, with a discussion of principles, by O. E. Meinzer. 333 pp., 31 pls. (incl. 5 maps), 110 figs.

The first of a series of papers on the general subject of ground water in the United States. Discusses principles of occurrence, kinds of rocks and their water-bearing properties, structure of rocks and its influence on ground water, and water-bearing formations in the United States. The paper is abundantly illustrated by diagrams and photographic views.

WATER-SUPPLY PAPER 492. Summary of hydrometric data in Washington, 1878-1919, by G. L. Parker and Lasley Lee. 371 pp., 9 pls. (incl. 1 map).

Records of stream flow in Washington were first collected by the United States Geological Survey in 1893, and from that time to September 30, 1919, records have been made at 209 gaging stations. The details of these records, which are given in 45 different volumes published by the Survey, are summarized in this paper in convenient form. Data based on earlier records showing the discharge of lower Columbia River since 1878 and Spokane River since 1891 are also given. The paper contains a bibliography.

WATER-SUPPLY PAPER 494. Outline of ground-water hydrology, with definitions by O. E. Meinzer. 75 pp., 35 figs.

This paper gives the results of an attempt to find the concepts involved in the science of ground-water hydrology, to ascertain their relations to one another, to state accurately what these concepts are, and to find terms for the concepts defined.

WATER-SUPPLY PAPER 497. The Salton Sea region, Calif., a geographic, geologic, and hydrologic reconnaissance, with a guide to desert watering places, by J. S. Brown. 308 pp., 10 pls. (incl. 4 maps), 18 figs.

One of the final reports on the desert watering place survey authorized by Congress in 1917. The places in this region at which water can be had are widely separated oases in a vast territory that must always remain essentially a desert, though it contains prosperous cities, fertile agricultural districts, and rich mines. The information given is of prime value to travelers. The present volume covers an area of 10,000 square miles in southeastern California that includes the Salton Sea, which lies far below sea level and has had a unique geologic history; the famous Imperial Valley, one of the largest irrigation districts in the country; and the Government experimental date gardens, which promise to establish a permanent industry.

WATER-SUPPLY PAPER 498. The lower Gila region, Ariz., a geographic, geologic, and hydrologic reconnaissance, with a guide to desert watering places, by C. P. Ross. 251 pp., 23 pls. (incl. 5 maps), 16 figs.

Another of the final reports on the survey of desert watering places authorized by Congress in 1917. Four preliminary guidebooks have been issued covering areas amounting to 60,000 square miles in southeastern California and southwestern Arizona, and the present paper is one of four detailed reports on the same areas. Besides specific information in regard to watering places and routes of travel, it gives general information in regard to the geography, geology, and hydrology of the region, some of it compiled from existing publications, but a large part of it new. The lower Gila region is mainly in Yuma and Maricopa counties, Ariz., north of Gila River and east of Colorado River. Among the illustrations in this report are three large-scale relief maps.

WATER-SUPPLY PAPER 501. Surface water supply of the United States, 1910-20, Part I, North Atlantic slope drainage basins; N. C. Grover, chief hydraulic engineer; C. H. Pierce, C. C. Covert, O. W. Hartwell, and G. C. Stevens, district engineers. 390 pp., 2 pls.

WATER-SUPPLY PAPER 502. Surface water supply of the United States, 1919 and 1920, Part II, South Atlantic slope and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. C. Stevens, C. G. Paulsen, and W. E. Hall, district engineers. 84 pp., 2 pls.

WATER-SUPPLY PAPER 503. Surface water supply of the United States, 1919 and 1920, Part III, Ohio River basin; N. C. Grover, chief hydraulic engineer; O. W. Hartwell, G. C. Stevens, W. E. Hall, W. R. King, and C. G. Paulsen, district engineers. 263 pp., 2 pls.

WATER-SUPPLY PAPER 505. Surface water supply of the United States, 1919 and 1920, Part V, Hudson Bay and upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. A. Lamb and W. G. Hoyt, district engineers. 293 pp., 2 pls.

WATER-SUPPLY PAPER 506. Surface water supply of the United States, 1919 and 1920, Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb, Robert Follansbee, W. G. Hoyt, and R. C. Rice, district engineers. 411 pp., 2 pls.

WATER-SUPPLY PAPER 510. Surface water supply of the United States, 1919 and 1920, Part X, The Great Basin; N. C. Grover, chief hydraulic engineer; A. B. Purton, H. D. McGlashan, F. F. Henshaw, C. G. Paulsen, and Robert Follansbee, district engineers. 354 pp., 2 pls.

WATER-SUPPLY PAPER 511. Surface water supply of the United States, 1919 and 1920, Part XI, Pacific slope basins in California; N. C. Grover, chief hydraulic engineer; H. D. McGlashan and F. F. Henshaw, district engineers. 464 pp., 2 pls.

WATER-SUPPLY PAPER 512. Surface water supply of the United States, 1919 and 1920, Part XII, North Pacific slope drainage basins, A, Pacific basins in Washington and upper Columbia River basin; N. C. Grover, chief hydraulic engineer; G. L. Parker and W. A. Lamb, district engineers. 268 pp., 2 pls.

Eight papers of a series giving results of stream gaging during the years ended September 30, 1919 and 1920.

WATER-SUPPLY PAPER 515. Surface water supply of Hawaii, July 1, 1918, to June 30, 1919; N. C. Grover, chief hydraulic engineer; C. T. Bailey and J. E. Stewart, acting district engineers. 127 pp.

The regular report on stream gaging.

WATER-SUPPLY PAPER 520 A. Variation in annual run-off in the Rocky Mountain region, by Robert Follansbee. 16 pp., 2 pls., 2 figs.

Gives the results of a study of records of stream flow at 20 gaging stations on 19 rivers in the Rocky Mountain region for periods ranging from 14 to 38 years.

WATER-SUPPLY PAPER 520-B. Additional ground-water supplies for the city of Enid, Okla., by B. C. Renick. 14 pp., 3 figs.

Report of an investigation made at the request of the city of Enid to obtain information bearing on a proposed increase in the city water supply. Concludes that at relatively small cost the present supply can be increased to yield 110 gallons a day per capita for 30,000 people.

WATER-SUPPLY PAPER 524. Surface water supply of the United States, 1921. Part IV, St. Lawrence River basin; N. C. Grover, chief hydraulic engineer; S. B. Soule, A. H. Horton, C. C. Covert, and C. H. Pierce, district engineers. 116 pp., 2 pls.

WATER-SUPPLY PAPER 527. Surface water supply of the United States, 1921. Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee and E. L. Williams, district engineers. 43 pp., 2 pls.

WATER-SUPPLY PAPER 528. Surface water supply of the United States, 1921. Part VIII, Western Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; C. E. Ellsworth, district engineer. 100 pp., 2 pls.

Three reports giving results of stream gaging in the basins indicated during the year ended Sept. 30, 1921.

MINERAL RESOURCES OF THE UNITED STATES, 1920; G. F. Loughlin, geologist in charge, division of mineral resources. Part I, Metals, 766 pp., 2 pls., 17 figs.

A consolidation of reports on the different metals published separately between May, 1921, and July, 1922, with a summary covering both metals and nonmetals.

MINERAL RESOURCES OF THE UNITED STATES, 1920; G. F. Loughlin, geologist in charge, division of mineral resources. Part II, Nonmetals, 333 pp., 2 pls., 25 figs., 1 insert.

A consolidation of chapters published at intervals between July, 1921, and December, 1922.

MINERAL RESOURCES OF THE UNITED STATES, 1921; G. F. Loughlin, geologist in charge, division of mineral resources. Part I, Metals, 751 pp., 1 pl., 14 figs.

MINERAL RESOURCES OF THE UNITED STATES, 1921; G. F. Loughlin, geologist in charge, division of mineral resources. Part II, Nonmetals, 688 pp., 1 pl., 53 figs., 1 insert.

These books consist of a consolidation of more than 60 separate chapters, which were issued at different dates between April, 1922, and October, 1923 (one chapter issued during the year). The grand total value of all mineral products for the year was about \$4,138,670,000, a decrease of 41 per cent from the total for 1920.

MINERAL RESOURCES OF THE UNITED STATES, 1922. 57 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1923. 1 advance chapter.

GEOLOGIC FOLIO 215. Hot Springs, Ark., by A. H. Purdue and H. D. Miser. 12 folio pages of text, 2 maps, 1 columnar-section sheet, 1 structure-section sheet, 8 pls., 8 figs.

The area described as the Hot Springs district covers about 245 square miles around the city of Hot Springs, Ark., mostly in Garland County. It lies in the eastern part of the Ouachita Mountain region, a mountainous province that extends from Atoka, Okla., to Little Rock, Ark. This folio sets forth the general geography and geology of this province as an introduction to the more detailed presentation of the geology of the Hot Springs district. The district is known principally for the famous hot springs from which its only city is named. These springs and the mountains adjacent to them are under the control of the Government as a national park. The origin of the hot springs is discussed at length. The principal mineral resources of the district are rock suitable for making oil-stones, road material, clay, and shale.

GEOLOGIC FOLIO 216. Carlyle-Centralia, Ill., by E. W. Shaw. 10 folio pages of text, 4 maps, 5 figs.

Describes an area of 466 square miles in southwestern Illinois, lying in the Till Plains section of the Central Lowland province, a region that consists chiefly of glaciated plains and lies between the Appalachian Highlands and the Great Plains. A general description of the geography and geology of this province is given as an introduction to the detailed description of the two quadrangles. The bed-rocks are exposed at few places in this area, being almost everywhere buried under beds of loess, glacial till, and alluvium, but information concerning them is afforded by records of borings made for oil and coal. The section on geologic history includes a detailed account of the glaciation of this area. Its chief economic mineral resources are coal, oil, and gas.

GEOLOGIC FOLIO 217. Ray, Ariz., by F. L. Ransome. 24 folio pages of text, 4 maps, 8 pls., 13 figs.

Describes the geology of an area of 250 square miles in Gila and Pinal counties, Ariz., in which the principal industries are the mining, milling, and smelting of copper ore. Ray and a few other settlements contain a total population of about 10,000, but much of the area is a wilderness. The geologic formations exposed in this area range in age from pre-Cambrian to Cretaceous, and the geologic history is a record of sedimentation, deformation, intrusion, metamorphism, eruption, uplift, and erosion. The copper deposits are the chief resources of the area, but it contains also ores that yield gold, silver, lead, zinc, and vanadium.

GEOLOGIC FOLIO 218. Riddle, Oreg., by J. S. Diller and G. F. Kay. 8 folio pages of text, 3 maps, 8 figs.

The Riddle quadrangle covers an area of 910 square miles in southwestern Oregon, between the Cascade Range on the east and the Coast Ranges and Klamath Mountains on the west. The population is about 5,000 and the chief industries are lumbering and mining. The geologic formations include both sedimentary and igneous rocks and are of Paleozoic and later age. These formations record repeated uplift and mountain building, subsidence and sedimentation, erosion, and volcanism. The mineral resources are gold, nickel, and copper. This folio describes the geology of the quadrangle and of the larger region of which it forms a part.

GEOGRAPHIC AND OTHER MAPS as follows. The maps marked with an asterisk (*) were published also with green overprint showing woodland.

Alabama

State of Alabama. Scale, 1 inch=8 miles.

Base map of the State of Alabama, printed in black. Shows county boundaries, location and names of all towns and most of the smaller settlements, railroads, rivers, and many of the smaller streams and water features. This map does not show contours.

Alaska

Alaska (relief map). Scale, 1 inch= $39\frac{1}{2}$ miles; no contour lines.

Shaded relief map in which the physical features are brought out by an overprint in shades of brown, on the conventional plan of assumed illumination from the northwest. The water features are shown in blue, and the glaciers are shown by a blue overprint in a conventional pattern. The shading brings out well the trend of the chief mountain ranges and the difference in height between the ranges of southern Alaska and those of the central and northern parts of the Territory, as well as the contrast in relief between the mountain ranges and the coastal plains, interior basins, and Arctic slope. The contrast of the brown-tinted land and the blue-tinted ocean emphasizes the raggedness of the coast of southeastern and southwestern Alaska and the comparative smoothness of the coast of western and northern Alaska. The map shows that the glaciers are confined to the higher mountains of the south and southeast and illustrates the fact that the existence of glaciers is more dependent on altitude and precipitation than on latitude alone.

Alaska Railroad—Seward to Matanuska coal field: Latitude, $59^{\circ} 40'$ to $61^{\circ} 53'$; longitude, 147° to 151° . Scale, 1 inch= 4 miles; contour interval, 200 feet.

Topographic map of the region adjacent to the southern third of the Alaska Railroad, including the country between Prince William Sound on the east and the head of Cook Inlet on the west, and extending from the Pacific Ocean at Seward northward to the Talkeetna Range. Considerable portions of the coast line and the adjacent country have been mapped in detail, as well as a belt of territory several miles wide along the line of the railroad, but the remainder of the region is only imperfectly known, and the features of some areas in it are represented only by blank spaces. Among the striking features shown are the deep floods of the northwest coast of Prince William Sound, the huge glaciers among the mountains back of that coast, and the great depression which separates the Kenai Mountains on the south from the Chugach Mountains on the north, and through which the waters of Prince William Sound and Cook Inlet almost meet.

Arizona

State of Arizona. Scale, 1 inch= 8 miles.

Base map of the State of Arizona, printed in two colors. Shows county boundaries, location and names of all towns and most of the smaller settlements, and railroads (in black) and rivers and many of the smaller streams and water features (in blue). This map does not show contours.

California

Bullard: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $119^{\circ} 45'$ to $119^{\circ} 52' 30''$. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of an area in Fresno and Madera counties at the northeast side of San Joaquin Valley, just south of the place where San Joaquin River emerges from the foothills of the Sierra. The area is crossed by several low southwestward-trending alluvial ridges built by distributaries of the river at times of flood, which are now traversed by irrigation ditches that bring water from the foothills. San Joaquin River crosses the northwestern part of the area. Part of the city of Fresno is included in the southern part of the area.

Citrus Cove: Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $119^{\circ} 15'$ to $119^{\circ} 22' 30''$. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of parts of Fresno and Tulare counties, in the eastern part of San Joaquin Valley, at the base of the foothills of the Sierra Nevada.

Clovis: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $119^{\circ} 37' 30''$ to $119^{\circ} 45'$. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of an area in Fresno County, in the eastern part of San Joaquin Valley.

Conejo: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $119^{\circ} 37' 30''$ to $119^{\circ} 45'$. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of part of Fresno County, in San Joaquin Valley, whose surface is crossed by an irregular line of depressions, 15 to 20 feet deep, which probably mark the course of a former distributary of Kings River. Many of the deeper depressions contain ponds, some of them intermittent. The area contains no permanent streams but is crossed by irrigation ditches that reach all parts of it.

Englebrecht Ranch: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $120^{\circ} 15'$ to $120^{\circ} 22' 30''$. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of an area in Fresno County, in the southwestern part of San Joaquin Valley. It contains no permanent streams and is inhabited only in a part of its northeast corner, which is irrigated by ditches.

Gravelly Ford: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $120^{\circ} 7' 30''$ to $120^{\circ} 15'$. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of an area in Madera and Fresno counties, on the alluvial plain of San Joaquin River. Across this plain the river flows in a channel 5 to 10 feet in depth.

Terndon: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $119^{\circ} 52' 30''$ to 120° . Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of an area in Fresno and Madera counties, in San Joaquin Valley a little east of the great bend of San Joaquin River, which crosses the northern part of the area, swinging from side to side of a slightly sinuous trench half a mile wide and 50 feet deep.

Laguna Seca Ranch: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $120^{\circ} 45'$ to $120^{\circ} 52' 30''$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 and 25 feet.

Map of an area in Fresno and Merced counties, on the west side of San Joaquin Valley, at the northeast base of the Panoche Hills.

Levis: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $120^{\circ} 22' 30''$ to $120^{\circ} 30'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 and 25 feet.

Map of an area in Fresno County, in the western part of San Joaquin Valley, at the northeast base of Monocline Ridge. The southwest corner is occupied by a part of Monocline Ridge, one peak of which stands 1,150 feet above sea level.

Malaga: Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $119^{\circ} 37' 30''$ to $119^{\circ} 45'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of an area in Fresno County, in the eastern part of San Joaquin Valley, including in its northwest corner part of the city of Fresno.

Mendota: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $120^{\circ} 15'$ to $120^{\circ} 22' 30''$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of parts of Madera and Fresno counties, in San Joaquin Valley, at the junction of San Joaquin River and Kings River Slough.

Monocline Ridge: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $120^{\circ} 30'$ to $120^{\circ} 37' 30''$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 and 25 feet.

Map of an area in Fresno County, in the western part of San Joaquin Valley, at the northeast base of Monocline Ridge.

Orangedale School: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $119^{\circ} 22' 30''$ to $119^{\circ} 30'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of an area in Fresno County, in the valley of Kings River, where it emerges from the foothills of the Sierra Nevada. Kings River emerges from its gorge at an elevation of 500 feet as a braided stream and is tapped by irrigation canals at several places in the next few miles. The floor of the valley widens from one-fourth of a mile at the mouth of the gorge to more than a mile at the south margin.

Redley: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $119^{\circ} 22' 30''$ to $119^{\circ} 30'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of parts of Tulare and Fresno counties, in the eastern part of San Joaquin Valley. Kings River flows southward across the western part of the area between banks 20 to 50 feet high, and an abandoned channel about 20 feet deep lies west of the present one.

Selma: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $119^{\circ} 30'$ to $119^{\circ} 37' 30''$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of a part of Tulare and Fresno counties, in San Joaquin Valley. Kings River, the principal stream of the region, crosses the southeast corner of the area, and its water, which is taken from the river farther up and carried in ditches or canals, is used to irrigate the entire area. A first-class automobile road crosses the area through the towns of Kingsbury and Selma.

Stokes Mountain: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $119^{\circ} 7' 30''$ to $119^{\circ} 15'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of part of Tulare County, along the foothills on the east side of San Joaquin Valley. Only the part of the area lying below 600 feet above sea level has been mapped.

Sultana: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $119^{\circ} 15'$ to $119^{\circ} 22' 30''$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 and 25 feet.

Map of an area in Fresno and Tulare counties, in the northeastern part of San Joaquin Valley. The area is crossed by the shallow furrows of a few intermittent streams. Two mountains—Smith Mountain and Curtis Mountain—rise boldly above the plain to heights of 1,019 and 1,310 feet, respectively.

Terra Loma School: Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $120^{\circ} 37' 30''$ to $120^{\circ} 45'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet and 25 feet.

Map of an area in Fresno County, in the southwestern part of San Joaquin Valley, at the base of the Panoche Hills.

Torrance: Latitude, $33^{\circ} 48'$ to $33^{\circ} 54'$; longitude, $118^{\circ} 18'$ to $118^{\circ} 26'$. Scale, 1 inch = 2,000 feet; contour interval, 5 feet.

Map of part of Los Angeles County, in southern California, on the coast just north of the San Pedro Hills, whose northern base enters the southern part of the area mapped. Off Redondo Beach the under-water contours reveal a deep channel, which leads out from the shore and descends sharply to a depth of more than 800 feet below sea level.

Tumey Hills: Latitude, $36^{\circ} 32' 30''$ to $36^{\circ} 37' 30''$; longitude, $120^{\circ} 37' 30''$ to $120^{\circ} 45'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 and 25 feet.

Map of part of an area in Fresno and San Benito counties, among the foothills on the southwest side of San Joaquin Valley. The area is crossed by the gulches of Panoche and Silver creeks, which are several hundred feet deep.

Wahitoke: Latitude, $36^{\circ} 37' 30''$ to $36^{\circ} 45'$; longitude, $119^{\circ} 22' 30''$ to $119^{\circ} 30'$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 and 25 feet.

Map of part of Fresno County on the east side of San Joaquin Valley, where Kings River emerges from the foothills of the Sierra Nevada. Kings River flows southward across the western part of the area in several shallow interlaced channels on a broad flood plain bounded by banks 25 to 30 feet high.

Wisdom Well: Latitude, $36^{\circ} 45'$ to $36^{\circ} 52' 30''$; longitude, $120^{\circ} 30'$ to $120^{\circ} 37' 30''$. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of part of Fresno County, in the western part of San Joaquin Valley. There are no permanent streams in the area, which is almost uninhabited, except a small part at its eastern margin, which is irrigated from deep wells.

Hawaii

* **Honua:** Latitude, 19° to $19^{\circ} 15'$; longitude, $155^{\circ} 30'$ to $155^{\circ} 45'$. Scale 1 inch = 1 mile; contour interval, 50 feet.

Map of part of the southeastern side of the island of Hawaii, extending from sea level in the southeastern part of the area to 7,350 feet in the northwest corner on the slope of Mauna Loa. The outlines of extensive recent lava flows are indicated, and the character of the lava, whether aa or pahoehoe, is shown by a convention of the contouring. Parasitic cones, fault scarps, and earthquake cracks are also indicated.

* **Kalae:** Latitude, $18^{\circ} 45'$ to 19° ; longitude, $155^{\circ} 35'$ to $155^{\circ} 50'$. Scale, 1 inch = 1 mile; contour interval, 50 feet.

Map of part of the southern angle of the island of Hawaii, which ranges in altitude from sea level along the shore to 1,150 feet at Puu Kauwila, near the northern margin. A great fault scarp extends from the shore northward beyond the area. The outlines of extensive recent lava flows are indicated, and the two kinds of lava, aa and pahoehoe, are shown by a convention of the contouring.

* **Pahala:** Latitude, 19° to $19^{\circ} 15'$; longitude, $155^{\circ} 15'$ to $155^{\circ} 30'$. Scale 1 inch = 1 mile; contour interval, 50 feet.

Map of part of the Kau district, on the southeastern coast of the island of Hawaii, on the southern slope of the great volcano of Mauna Loa. The surface of the area rises from sea level to 2,700 feet in the northwest corner. The outlines of several recent lava flows are indicated, as well as a number of large cracks and a few parasitic cones, and the difference in the character of the surface of the two sorts of lava, aa and pahoehoe, is shown by a convention of the contouring.

Idaho—Oregon

Snake River. Plan and profile of Snake River, Lewiston, Idaho, to Huntington, Ore. Scale, 1 inch = $\frac{1}{2}$ mile; contour interval on land, 25 feet, on river surface, 5 feet; vertical scale of profiles, 1 inch = 20 feet. Size, 20 by 19 inches (except sheet I, which is 23 by 19 inches). 17 sheets (10 plans, 7 profiles).

Sheets A to H show the course of Snake River from the mouth of Burnt River, near Huntington, Ore., to the mouth of Clearwater River, at Lewiston, Idaho. All rapids and islands in the stream and the sand flats along its course are shown, and the form of the immediately adjacent slopes is shown by contours. Sheet I is a map of the part of the Nez Perce National Forest that lies between Snake and Salmon rivers. Sheet J shows the topography of several proposed dam sites, on the scale of 1 inch to 400 feet and with 10-foot contours. Sheets K to Q show the profile of Snake River throughout the stretch mapped.

Illinois

* **Buda:** Latitude, $41^{\circ} 15'$ to $41^{\circ} 30'$; longitude, $89^{\circ} 30'$ to $89^{\circ} 45'$. Scale, 1 inch = 1 mile; contour interval, 20 feet.

Map of an area in Bureau County, in the Glacial Till Plains. The most prominent features of the relief are several broad, irregular morainal ridges 50 to 200 feet high. The Illinois and Mississippi Canal crosses the area from east to west through a low gap in the moraine.

* **Dongola:** Latitude, $37^{\circ} 15'$ to $37^{\circ} 30'$; longitude, 89° to $89^{\circ} 15'$. Scale, 1 inch = 1 mile; contour interval, 20 feet.

Map of parts of Union, Pulaski, Johnson, and Alexander counties, in the southern end of the State. An old abandoned river valley, 3 to 4 miles wide, crosses the southern part of the area and is traversed by Cache River in a marsh-bordered course, which is remarkably straight, as compared with the meandering courses of the other streams. The southern margin of the area lies in the Mississippi embayment portion of the Gulf Coastal Plain.

Monmouth: Latitude, $40^{\circ} 45'$ to 41° ; longitude, $90^{\circ} 30'$ to $90^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Warren County, in the Till Plains. The nearly flat surface of the area lies 700 to 785 feet above sea level and is cut to a depth of 20 to 60 feet by the steep-sided valleys of several creeks and by the ravines of numerous small tributaries.

Illinois-Missouri

onesboro: Latitude, $37^{\circ} 15'$ to $37^{\circ} 30'$; longitude, $89^{\circ} 15'$ to $89^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet. (New edition, showing entire quadrangle; previous edition showed only the portion in Illinois.)

Map of parts of Union and Alexander counties, Ill., and Cape Girardeau County, Mo., in the extreme southeast corner of the Ozark upland. The summit of Atwood Ridge rises 900 feet above sea level. Mississippi River flows southward across the western part of the area in a trench 3 to 4 miles wide and nearly 300 feet deep.

Illinois-Wisconsin

[See also Wisconsin-Illinois]

Grays Lake: Latitude, $42^{\circ} 15'$ to $42^{\circ} 30'$; longitude, 88° to $88^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of parts of Lake and McHenry counties, Ill., and Kenosha County, Wis., in the Eastern Lake section. The terminal moraine of the Lake Michigan lobe of the Wisconsin ice sheet traverses the western part of the area, where some knolls and short ridges stand 100 feet above the general level. Many of the hollows throughout the area are occupied by swamps and small ponds, and Fox River flows southward across its western part through a chain of lakes of irregular form, most of which have marshy shores.

Kentucky

Bowling Green: Latitude, $36^{\circ} 45'$ to 37° ; longitude, $86^{\circ} 15'$ to $86^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Warren, Allen, and Simpson counties, in a relatively low part of the Highland Rim Plateau. The northwestern half of the area is a gently rolling plain, which stands 500 to 600 feet above sea level and which, especially in its eastern part, is pitted with hundreds of sinkholes and larger irregular depressions. Nearly all the drainage ways except the large streams are underground. The southeastern half of the area is an upland, whose rather irregular surface, much cut by ravines, lies 600 to 800 feet above sea level and is drained chiefly by surface streams. Barren River and several branches of Drakes Creek cross the area in meandering trenches cut 100 feet or more below the level.

Mammoth Cave: Latitude, 37° to $37^{\circ} 15'$; longitude, 86° to $86^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Edmonson, Barren, Warren, and Hart counties, near the northwestern margin of the Highland Rim Plateau. The upland surface is cut by the winding trenches of Green and Nolin rivers. The conspicuous features of the area are the absence of surface drainage in a large part of it and the hundreds of sink holes. Mammoth Cave is in a ridge in the northeast-central part of the area, among the largest and deepest sinks.

State of Kentucky (relief map). Scale, 1 inch=8 miles; no contour lines.

Shaded relief map in which the physical features are brought out by an overprint in shades of brown, on the conventional plan of assumed illumination from the northwest. The water features are shown in blue. The shading brings out strongly the hilly character of the two coal fields of the State, particularly the eastern field, in which the topography is very rugged. A belt of hills surrounds the bluegrass region of Lexington and Frankfort, accentuating the level character of this region, which is broken only by the deep gorges of Kentucky and Licking rivers. The Jackson Purchase region, west of Tennessee River, is the lowest part of the State. The only mountainous topography is in the southeast corner of the State, where Pine and Cumberland mountains, typical Appalachian ridges, enter the State from the south.

Maine

Farmington: Latitude, $44^{\circ} 30'$ to $44^{\circ} 45'$; longitude, 70° to $70^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Franklin, Kennebec, and Somerset counties, just off the southeastern border of the mountainous part of the State. More than half the area is forested, the cultivated land being limited to that which is most easily accessible. Sandy River, a tributary of the Kennebec, drains all of the area except the southwestern corner, which is crossed by Androscoggin River. The map shows a secondary automobile highway across the area from south to north, passing through the towns of Jay, Wilton, Farmington, and Fairbanks. South of Chesterville, for a distance of 4 miles, a road occupies the crest of a narrow ridge which in places is 50 feet high. Such ridges, known as eskers, were formed under a great ice sheet that once covered all this region.

Michigan

- * Marshall: Latitude, $42^{\circ} 15'$ to $42^{\circ} 30'$; longitude, $84^{\circ} 45'$ to 85° . Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of an area in Calhoun and Eaton counties, in the western part of the Thumb Upland. Much of the area is occupied by irregular morainal ridges and groups of small knolls 50 to 150 feet high, interspersed with numerous kettle holes, some of which contain small ponds. Much of the low ground between the morainal ridges is occupied by swamps or ponds, and most of the small streams have been artificially straightened by ditching.

Mississippi

- * Morton: Latitude, $32^{\circ} 15'$ to $32^{\circ} 30'$; longitude, $89^{\circ} 30'$ to $89^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in the eastern part of the Gulf Coastal Plain, between 25 and 40 miles east of Jackson, mostly in Scott County, though it extends westward about a mile into the eastern part of Rankin County.

- * Pelahatchee: Latitude, $32^{\circ} 15'$ to $32^{\circ} 30'$; longitude, $89^{\circ} 45'$ to 90° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Rankin, Scott, and Madison counties, in the Coastal Plain. The principal streams flow in zigzag courses on flood plains a mile or so in width, which in some places are marshy.

- * Tupelo: Latitude, $34^{\circ} 15'$ to $34^{\circ} 30'$; longitude, $88^{\circ} 30'$ to $88^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Lee, Itawamba, Prentiss, and Union counties, near the inner margin of the Gulf Coastal Plain.

Missouri

[See also Illinois-Missouri]

- * Polo: Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, 94° to $94^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of most of the western half of Caldwell County and a strip 2 to 3 miles wide along the eastern border of Clinton County near and south of Cameron. Shows also a narrow strip at the north edge of Ray County and a very small part of Dekalb County. This area lies not far east of St. Joseph in the southern part of the dissected till plains of the Central Lowland. In the region that was traversed by one or more of the oldest of the glaciers of the great ice age. Most of the drainage is tributary to Grand River, but the streams in the northwestern part flow directly to the Missouri.

Montana

State of Montana. Scale, 1 inch=8 miles.

Base map of the State of Montana, in two sheets, printed in two colors. Shows county boundaries, location and names of all towns and most of the smaller settlements, and railroads (in black) and rivers and many of the smaller streams and water features (in blue). This map does not show contours.

New York

- * Cattaraugus: Latitude, $42^{\circ} 15'$ to $42^{\circ} 30'$; longitude, $78^{\circ} 45'$ to 79° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Cattaraugus County, near the northwestern margin of the Allegheny Plateau. The northern and northwestern parts of the area are occupied by a huge recessional moraine, through which Cattaraugus Creek and its south branch have cut postglacial gorges, parts of which are between rock walls several hundred feet high. These gorges, although very little known, are two of the deepest of the postglacial gorges of western New York. The subcontinental divide between the drainage basins of the St. Lawrence and the Mississippi crosses the quadrangle from east to west in a zigzag course, Conewango, Little Valley, and other creeks in the southern part of the area being tributaries of Allegheny River, whereas Cattaraugus Creek flows to Lake Erie.

- * Randolph: Latitude, 42° to $42^{\circ} 15'$; longitude, $78^{\circ} 45'$ to 79° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Cattaraugus County, in the Allegheny Plateau. Allegheny River flows southwestward across the area. From Cold Spring a broad preglacial valley extends northwestward beyond the limits of the area. This valley is crossed near Price Corners by the terminal moraine of the Wisconsin drift sheet that now forms the divide between Cold Spring Creek, which flows directly to the river, and Little Conewango Creek, whose waters join the river farther down after taking a devious route. The southeastern part of the area is included in the new Allegany State Park.

Santa Clara: Latitude, $44^{\circ} 30'$ to $44^{\circ} 45'$; longitude, $74^{\circ} 15'$ to $74^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Franklin County, in the northern part of the Adirondacks. The area shows the effects of heavy glaciation in the rounded contour of the hills, the drift-choked and swampy valleys, and the diverted and unsystematic drainage, and it contains several kame and kettle moraines and some chains of eskers.

Oregon

[See also Idaho-Oregon]

Mount Angel: Latitude, 45° to $45^{\circ} 15'$; longitude, $122^{\circ} 45'$ to 123° . Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of parts of Marion, Clackamas, and Yamhill counties, in the eastern part of the Willamette Valley. The greater part of the area is an alluvial flat that rises from 75 feet above sea level in the northwest corner to 200 feet in the southeast corner, where a few outliers of the foothills reach altitudes of about 500 feet. The principal streams flow in meandering courses in flat-bottomed trenches 25 to 50 feet below the general level.

Reedsport: Latitude, $43^{\circ} 30'$ to $43^{\circ} 45'$; longitude, 124° to $124^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of parts of Douglas and Coos counties, on the coast at the mouth of Umpqua River. The greater part of the area is rather rough, being occupied by the western foothills of the Oregon Coast Range, some peaks of which, in the southeastern part of the area, stand 1,500 feet above sea level. Along the coast is a belt about a mile wide and less than 100 feet above the sea, occupied chiefly by wind-blown sand, which has choked the mouths of several valleys so that they are now occupied by narrow, winding lakes. Most of the area, which is very sparsely settled, is in the Siuslaw National Forest.

State of Oregon. Scale, 1 inch=1 mile.

Base map of the State of Oregon, printed in two colors. Shows county boundaries, location and names of all towns and most of the smaller settlements, and railroads (in black) and rivers and many of the smaller streams and water features (in blue). This map does not show contours.

Pennsylvania

Howard: Latitude, 41° to $41^{\circ} 15'$; longitude, $77^{\circ} 30'$ to $77^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Clinton and Center counties, partly in the Allegheny Plateau and partly in the Appalachian Ranges. In the northeastern part of the area the West Branch of Susquehanna River flows in a gorge nearly 1,000 feet deep and only a mile wide at the top. The plateau is bounded on the southwest by the escarpment of the Allegheny Front, marking an abrupt descent to the Bald Eagle Valley. Published also in an edition with gray overprint showing the relief by shading.

Milton: Latitude, 41° to $41^{\circ} 15'$; longitude, $76^{\circ} 45'$ to 77° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area that includes parts of Lycoming, Union, Northumberland, and Montour counties, in the Appalachian Valley belt southeast of Williamsport. The quadrangle is crossed by the West Branch of Susquehanna River, which flows at levels between 430 and 500 feet above the sea. State Highway No. 18 runs southward from Williamsport to Muncy and thence southward through the Muncy Hills to Milton, and the valley of the river is traversed by railroads.

Shippensburg: Latitude, 40° to $40^{\circ} 15'$; longitude, $77^{\circ} 30'$ to $77^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Franklin, Cumberland, Perry, and Huntingdon counties, in the Appalachian Valley and Ranges. The extreme southeast corner of the area lies on the lowermost slope of the northwestern base of South Mountain.

Trout Run: Latitude, $41^{\circ} 15'$ to $41^{\circ} 30'$; longitude, 77° to $77^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Lycoming County, partly in the Allegheny Plateau and partly in the Appalachian Valley belt. The surface of the plateau is trenched by the deep gorge of Lycoming Creek, which at some places reaches a depth of 1,500 feet, and by many smaller valleys and ravines. The Allegheny Front crosses the area a little south of its center as a bold escarpment 600 to 900 feet high. The extreme south-east corner of the area, less than 600 feet above sea level, is in the valley of the West Branch of Susquehanna River.

Tyrone: Latitude, $40^{\circ} 30'$ to $40^{\circ} 45'$; longitude, 78° to $78^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Huntingdon, Blair, and Center counties, among the Appalachian Ranges. The north-central part of the area is occupied by the broad Nittany Valley. On the northwest the Nittany Valley is separated from the Bald Eagle Valley by the nearly even-crested ridge of Bald Eagle Mountain, which rises to 1,800 feet in some points. The northwest corner of the area lies at an altitude of 2,300 feet on the crest of the Allegheny Front. Juniata River and the Frankstown Branch of that stream cross the area in narrow, steep-walled trenches and cut through Bald Eagle and Tussey mountains in deep gorges. Published also in an edition with gray overprint showing the relief by shading.

Texas

- * Ketchum Mountains: Latitude, $31^{\circ} 15'$ to $31^{\circ} 30'$; longitude, 101° to $101^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in Irion County, in the Texas Hill section of the Great Plains. The southeastern part of the area lies on the northern fringe of the Edwards Plateau. The remainder of the area is chiefly a lower upland, whose surface is cut into irregular mesas by Middle Concho River, the only permanent stream in the area.

- Lopena Island: Latitude, $26^{\circ} 45'$ to 27° ; longitude, $97^{\circ} 15'$ to $97^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 5 feet.

Map of part of Kenedy County, on the Gulf coast near the southern corner of the State. Only in the western half of the area is there land, and most of this part consists of a tidal flat, Laguna Madre, which is separated from the Gulf by the long barrier beach called Padre Island.

- * Saltillo Ranch: Latitude, $26^{\circ} 45'$ to 27° ; longitude, $97^{\circ} 30'$ to $97^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 5 feet.

Map of part of Kenedy County, in the Gulf Coastal Plain. The land surface of the area, which is everywhere less than 50 feet above sea level, is crossed by a maze of small, roughly linear southeastward-trending ridges and hollows. Apparently all the inequalities in the relief of the area are due to the work of the wind. The area contains no streams. Its eastern part is occupied by the tidal flat of Laguna Madre.

- * Sierra Madera: Latitude, $30^{\circ} 30'$ to $30^{\circ} 45'$; longitude, $102^{\circ} 45'$ to 103° . Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of part of Pecos County, in the eastern part of the trans-Pecos country. Most of the area is occupied by several irregular groups of small mountains which are separated and surrounded by sloping plains.

Vermont

- * Camels Hump: Latitude, $44^{\circ} 15'$ to $44^{\circ} 30'$; longitude, $72^{\circ} 45'$ to 73° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Chittenden, Washington, Addison, and Lamont counties, in the Green Mountains. Camels Hump, 4,083 feet above sea level, in the south-central part of the area, is one of the highest points in the State. Winooski River flows northwestward across the center of the area in a remarkably straight gorge cut down to about 400 feet. A narrow strip of flood plain in the bottom of the gorge is traversed by the Central Vermont Railway and the Theodore Roosevelt International Highway, and the Green Mountain Club trail has been laid out along or near the crest of the main range of the mountains.

Virginia

[See West Virginia-Virginia]

Washington

- Corfu: Latitude, $46^{\circ} 45'$ to 47° ; longitude, $119^{\circ} 15'$ to $119^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in Grant and Adams counties, in the Walla Walla Plateau portion of the Columbia Plateaus. The entire area is a part of a great lava plateau. Two great ridges of lava cross the area from east to west. The Frenchman Hills, in the northern part, reach an altitude of 1,740 feet above sea level at one point, and the Saddle Mountains, in the southern part, reach altitudes of 2,000 and 2,200 feet in several peaks. Crab Creek flows southward and westward across the area, in a large valley that was occupied by Columbia River in late Pleistocene time. The northern part of the area is a portion of the bed of a late Pleistocene lake, now largely flooded with drifting sand.

West Virginia

- * Alderson: Latitude, $37^{\circ} 30'$ to $37^{\circ} 45'$; longitude, $80^{\circ} 30'$ to $80^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Monroe, Summers, and Greenbrier counties, in the Greenbrier Basin section of the Appalachian Ranges. The area is a confused maze of short, irregular ridges trending in different directions. A belt in the eastern part contains many sink holes. Greenbrier River crosses the northern part of the area.

- * Callaghan: Latitude, $37^{\circ} 45'$ to 38° ; longitude, 80° to $80^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of part of Greenbrier County, W. Va., among the Appalachian Ranges, several of which cross the area from northeast to southwest. Allegheny Mountain, along whose crest the State boundary lies, here forms the divide between the streams flowing to the Ohio and those flowing to the Atlantic.

Capon Bridge: Latitude, $39^{\circ} 15'$ to $39^{\circ} 30'$; longitude, $78^{\circ} 15'$ to $78^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Hampshire and Morgan counties, among the Appalachian Ranges, a number of which trend north-northeastward across it. Capon Mountain, the highest, stands 2,550 feet above sea level at one point, and the crests of other ridges range from 1,500 to 2,800 feet. Capon River flows northward through the area.

Clintonville: Latitude, $37^{\circ} 45'$ to 38° ; longitude, $80^{\circ} 30'$ to $80^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Greenbrier and Summers counties, partly in the Kanawha Hills section of the Allegheny Plateau and partly in the Greenbrier Basin section of the Appalachian Ranges. A group of mountains, which culminates at 4,035 feet above sea level in Cross Mountain, occupies the northeastern part of the area; and a similar group, which culminates at 3,945 feet in Keeney Knob, occupies the southwestern part. Meadow River flows across the area in a flood plain that is in some places more than a mile wide. The southeastern part of the area is crossed by James River and by Kanawha Turnpike, the principal and oldest highway across the mountains of central West Virginia. Published also in an edition with gray overprint showing the relief by shading.

Edinburg: Latitude, $38^{\circ} 45'$ to 39° ; longitude, $78^{\circ} 30'$ to $78^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of a small area in the Appalachian Ranges, in Hardy County, W. Va.

Hanging Rock: Latitude, $39^{\circ} 15'$ to $39^{\circ} 30'$; longitude, $78^{\circ} 30'$ to $78^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Hampshire and Mineral counties, among the Appalachian Ranges. The South Branch of Potomac River flows in a sinuous course northeastward across the northwestern part of the area.

Middletown: Latitude, 39° to $39^{\circ} 15'$; longitude, $78^{\circ} 15'$ to $78^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Hampshire County among the Appalachian Ranges. The area is crossed by two mountain ranges whose crests rise 1,400 to 2,800 feet above sea level. Between them, at a general altitude of about 1,200 feet, lies the valley of Capon River, which is cut by the immediate trench of the river, about 400 feet deep and half a mile wide.

Orkney Springs: Latitude, $38^{\circ} 45'$ to 39° ; longitude, $78^{\circ} 45'$ to 79° . Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Hardy County, W. Va., among the Appalachian Ranges, several of which cross the area mapped. The crests of the ranges stand 2,200 to 3,200 feet above sea level. Moorefield and Lost rivers flow northeastward in valleys 1,000 feet or more deep, and several tributaries of Lost River cut through some of the ranges in deep gorges.

Pearisburg: Latitude, $37^{\circ} 15'$ to $37^{\circ} 30'$; longitude, $80^{\circ} 30'$ to $80^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of part of Monroe County, W. Va., among the Appalachian Ranges, two of which cross the area mapped. Peters Mountain, along whose crest the State boundary lies, stands 3,400 to 4,000 feet above sea level. The northwest corner of the area stands 2,100 to 2,300 feet above sea level and is cut by small valleys about 200 feet deep.

Richwood: Latitude 38° to $38^{\circ} 15'$; longitude, $80^{\circ} 30'$ to $80^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Greenbrier and Nicholas counties, in the Kanawha Hills section of the Allegheny Plateau.

White Sulphur Springs: Latitude, $37^{\circ} 45'$ to 38° ; longitude, $80^{\circ} 15'$ to $80^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Greenbrier County, mainly in the Greenbrier Basin section of the Appalachian Ranges. The plateau surface is trenched to a depth of 100 to 200 feet by the narrow, V-shaped valleys of a few small streams, but sink holes abound, and the drainage of a large part of the surface is underground. The eastern third of the area is occupied by the ranges of Greenbrier and other mountains. The extreme southeast corner of the area is crossed by the ridge of Allegheny Mountain, which forms the divide between the drainage flowing to the Ohio and that flowing directly to the Atlantic; beneath this ridge passes the Allegheny tunnel of the Chesapeake & Ohio Railway. Greenbrier River flows southward across the middle of the area in a meandering trench incised 800 to 500 feet in the plateau.

West Virginia-Virginia

* **Ronceverte:** Latitude, $37^{\circ} 30'$ to $37^{\circ} 45'$; longitude, $80^{\circ} 15'$ to $80^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of parts of Monroe and Greenbrier counties in West Virginia and Craig and Alleghany counties in Virginia, among the Appalachian Ranges. The northwestern part of the area lies in the broad basin of Greenbrier River. Published also in an edition with gray overprint showing the relief by shading.

Wisconsin

[See also Illinois-Wisconsin.]

* Blanchardville: Latitude, $42^{\circ} 45'$ to 43° ; longitude, $89^{\circ} 45'$ to 90° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Iowa, Dane, Lafayette, and Green counties, in the Driftless Area.

Wisconsin-Illinois

* South Wayne: Latitude, $42^{\circ} 30'$ to $42^{\circ} 45'$; longitude, $89^{\circ} 45'$ to 90° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Lafayette and Green counties, Wis., and Stephenson and Jo Davies counties, Ill., in the Driftless Area. Pecatonica River and its East Branch cross the area in meandering courses in flat-bottomed valleys half a mile wide and 150 to 200 feet deep.

GEOLOGIC BRANCH**SCOPE AND ORGANIZATION OF WORK**

The field and laboratory work of the geologic branch should logically be coextensive with the science of geology. The fundamental principles of the science are now more firmly established and more broadly applicable than ever before, and intense specialization in many fields, in harmony with that prevailing in all scientific research, is constantly accelerating the growth of geology and increasing its useful applications. Ideally the work of the Geological Survey should embrace all fields of geologic research and should keep pace with the progress of the science. Practically, in view of the limits imposed upon personnel and funds and laboratory space, this ideal is unattainable. The efforts of the organization are therefore directed mainly to the performance of work that will be of greatest obvious public benefit. A balance is struck between fundamental research that may yield practical results only after many years and the solution of special problems by work whose results are without doubt immediately useful.

The Geological Survey cooperates actively with other Government bureaus, with most of the State geological surveys, with many of the geologic faculties of the universities, and with several of the great endowed research institutions. Through correlated research, attendance at scientific congresses, interchange of ideas, and conjoined effort the many workers in this branch of science bring to the solution of current practical problems the best geologic thought of the day.

Field and laboratory investigations in many departments of geology are made. The field studies yield geologic maps showing stratigraphy and structure and interpretative reports on such subjects as glaciology and physiography; work done in field and laboratory yields results in paleontology, mineralogy, petrography, chemistry, and physics; and combinations of all these results are used in solving practical problems connected, for example, with the occurrence, reserves, and availability of fuels, minerals and water resources, the strength of foundations of dams, or the suitability of reservoir sites. The work done yields by-products that are of present scientific value or of ultimate practical application, though between the two classes no sharp line of demarcation can be drawn, for the scientific theory of to-day governs the business practice of to-morrow.

Statistical compilations of mineral production and resources are directed to the solution of problems of mineral economics. The ideal

There is to use specialists geologically trained in order that a knowledge of such fundamental factors as reserves (both domestic and foreign), markets, and general business conditions may be intelligently correlated and interpreted to yield an invaluable fund of useful information. It is unfortunate that money is not available to enable the Survey to attain this ideal throughout the work, for mere statistics without such a setting are of correspondingly less value.

Research work in chemistry and physics supplements and supports geologic work. Many of the most practical geologic investigations could not be carried on without such aid.

The work of the geologic branch is performed through three coordinate divisions—geology, chemical and physical research, and mineral resources. The general organization during the fiscal year has been as follows:

Geologic branch: W. C. Mendenhall, chief geologist.

Division of geology: W. C. Mendenhall, geologist in charge.

Division of mineral resources: G. F. Loughlin, geologist in charge until May 15; F. J. Katz, geologist in charge from May 15 to June 30.

Division of chemistry and physics: George Steiger, chief chemist, acting in charge.

APPROPRIATIONS

The act making appropriations for the Department of the Interior for the fiscal year ending June 30, 1924, carried four items, aggregating \$484,950, by which the work of the geologic branch was maintained. In addition, geologic field work required for the classification of mineral lands was done by means of the appropriation made for the classification of the public lands, at a total cost of \$44,000. By comparison with the amounts appropriated for similar work in the preceding fiscal year the figures given show a decrease of \$750 in the amount available for work on mineral resources and an increase of \$10,350 in the amount available for land classification.

The Geological Survey cooperates with other organizations, State and Federal, by assigning its members to the study of special problems, either wholly at the expense of the organization that requires the cooperation or by sharing the cost of the work. The Forest Service, the General Land Office, the Office of Indian Affairs, the Department of Justice, the Bureau of Reclamation, and several States thus received the benefit of the special training available in the branch. The cost to the cooperating organizations during the fiscal year, either in the form of salaries assumed or field expenses borne, was \$16,000 (repay work \$6,600, cooperating States \$9,400). The total amount made available to the branch for the fiscal year, including direct appropriations, allotments for land classification, and cooperative funds, was thus \$544,950.

DIVISION OF GEOLOGY

ORGANIZATION AND PERSONNEL

The division of geology as at present organized includes the ten sections indicated below. It also exercises technical supervision over the section of geologic map editing, a part of the publication branch.

Geology of metalliferous deposits: F. L. Ransome, geologist in charge until May 15, 1924; G. F. Loughlin, geologist in charge from May 15 to June 30.
 Paleontology and stratigraphy: T. W. Stanton, geologist in charge.
 Glacial geology: W. C. Alden, geologist in charge.
 Geology of iron and steel metals: E. F. Burchard, geologist in charge.
 Coastal Plain investigations: L. W. Stephenson, geologist in charge.
 Areal geology: Sidney Paige, geologist in charge.
 Geology of nonmetalliferous deposits: G. R. Mansfield, geologist in charge.
 Petrology: E. S. Larsen, jr., geologist in charge until October 1, 1923; C. S. Ross, geologist acting in charge from October 1, 1923, to June 30, 1924.
 Geology of oil and gas fields: K. C. Heald, geologist in charge.
 Geology of coal fields: W. T. Thom, jr., geologist in charge.

In addition to the units of administrative organization the division includes two advisory committees—the committee on geologic names, T. W. Stanton, chairman, and the physiographic committee, M. R. Campbell, chairman. These committees consider in detail all problems falling within their respective fields and advise the chief geologist of their findings as a basis for administrative action.

At the beginning of the fiscal year the division included 124 geologists of various grades. During the year 5 resigned, 1 retired, 1 was transferred to another branch, and 15 were added, so that the number employed at the end of the year was 132. The division included also 5 draftsmen and 7 preparators of fossils and skilled laborers. In the clerical force there were 4 accessions and 3 separations, and the number employed at the end of the year was 31.

The resignation of Frederick Leslie Ransome, who had directed the work of the section of metalliferous deposits since 1912, is a great loss to the Survey. Doctor Ransome resigned to become professor of economic geology at the University of Arizona.

T. Wayland Vaughan and Esper S. Larsen, jr., each distinguished in his own field of work, have also left the Survey, Doctor Vaughan to become Director of Scripps Institute at Palo Alto, Calif., and Doctor Larsen to become professor of petrology at Harvard University.

J. S. Diller retired from the Survey December 31, 1923, after 40 years of active service.

B. S. Butler was reinstated as a member of the Survey April 16, 1924, after four years of service in economic research concerning copper deposits in Michigan under the auspices of Harvard University and the Calumet & Hecla Mining Co.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the division of geology for the fiscal year were as follows:

Geologic surveys.....	\$300,000
Classification of lands.....	44,000
Scientific assistants.....	17,700
Search for potash deposits (allotted from the appropriation for chemical and physical research).....	5,600
Repayments on account of work done for other Government establishments or other Geological Survey units.....	6,600
	<hr/>
	373,900

The expenditures from these funds may be classified by subjects approximately as follows:

Economic geology of metalliferous deposits.....	\$31,300
Economic geology of nonmetalliferous deposits.....	15,500
Economic geology of fuels (oil, gas, coal).....	95,000
Scientific researches not directly connected with economic geology (paleontology, glaciation, Coastal Plain formations, etc.).....	123,400
Supervision, administration, salaries of clerical, technical, and skilled-labor forces, purchase and repair of instruments, office supplies, etc.....	106,500
Reserve and balance.....	2,200
	373,900

Of the amounts available for geologic work, approximately \$84,000 was used directly to pay field expenses, including those incurred in the search for potash. About 65 per cent of this amount was expended for work done west of the one hundredth meridian and about 35 per cent for work done east of it.

COOPERATION

By cooperation, formal or informal, with State geological surveys, research institutions, and other organizations the sum of geologic work accomplished during the year is materially increased. Examples of such cooperative work with State surveys are the completion of a geologic map of Arizona, the preparation of a revised geologic map of Alabama, the preparation of a map and report on the geology and oil possibilities of Russell County, Kans., the preparation of a bulletin on the physiography of Georgia and of another on the stratigraphy of Mississippi (all these to be published by the States), and the preparation of a report on the ground waters of Mississippi to be published by the United States Geological Survey. A report on the Valley coal fields of Virginia, in preparation, is to be published by the State.

The publication of the English edition of a report on the geology of Haiti completes part of an important cooperative work, the expenses of which were borne by the Haitian Government. The French edition is now in type.

The identification of fossils sent in from different parts of the United States and from the West Indies and Central and South America is a cooperative service of great usefulness to State surveys and to the oil industry. Studies of Samoan fossils were made in cooperation with the Carnegie Institution of Washington.

A detailed study of the San Andreas rift, in southern California, is being made by L. F. Noble as the Survey's part of cooperative earthquake studies under the auspices of the Seismological Society of America. The Carnegie Institution and the Coast and Geodetic Survey are each carrying on coordinated parts of this work.

In its capacity as expert adviser in the solution of problems involving geology and mineral economics the cooperation of the Survey is increasingly requested by many Federal departments. Such cooperation was maintained with the Office of Indian Affairs in

matters involving the leasing of oil lands, with the Bureau of Reclamation in the examination of reservoir and dam sites, and with the Forest Service in the examination of lands proposed for purchase under the Appalachian National Forest Act. Assistance has been given to the Department of Justice, and a report on the zinc deposits of the world is being prepared for the Department of Commerce.

Through the service of the Director as a member of the United States Coal Commission the largest possible use was made of the Survey's data and personnel in an inquiry of dominant public interest. Similar cooperation has resulted from his appointment on the President's Naval Oil Commission.

GENERAL REVIEW OF WORK OF THE YEAR

Partly, perhaps, because the adjustment of Government salaries to new price levels lags somewhat behind such adjustment in outside institutions, but largely because the Survey has always been compelled to surrender its trained specialists to commercial companies and educational institutions, separations from the technical force have continued. Two universities and one research institution have taken three men, each difficult to replace in his particular field.

The work of the year, which is set forth below in detail by States, was, as heretofore, so directed as to assist the economical development of the country's mineral resources. It is gratifying, however, to note that many so-called "purely scientific" investigations are by-products of the work of solving "practical" problems and derive a large part of their value from their connection with that work.

Although the limit placed on the funds available for the classification of millions of acres of withdrawn coal lands prevents rapid progress in that work, it nevertheless goes steadily forward from year to year. In connection with this work certain kinds of research concerning coal are pressingly demanded, such as research as to its nature and composition, its origin, and its special fitness for use in particular industries. So far as money and personnel will permit, such research is being made, for the ever-increasing demand for power implies the necessity for a more intelligent and therefore more economical use of the heat units in coal, now so lamentably wasted.

The intensive study of oil fields continues, and more general surveys designed to outline favorable territory have been made, notably in the Northwest. The classification of oil lands by the Survey must be based upon accurate geologic information and can not proceed faster than the information is accumulated. Research here also follows closely the pressing need for accurate information. The employment of more refined methods of study—by means of the microscope, for example—in discovering the distinguishing characteristics of key strata has been considerably increased and has afforded better interpretations of well logs, with all the advantages that follow this method of ascertaining underground structure in regions where surface exposures are inadequate.

Throughout the year a form of research that had been neglected temporarily—the study of the nature and origin of oil shale—has been carried on. Field studies leading to a clearer understanding of

the conditions under which oil shales were laid down have been coupled with laboratory research—by the microscope and by chemical, biological, and botanical studies—in attempts to determine the constitution of oil shale, not only with reference to its commercial use but with reference to its bearing on the origin of oil. The results of these studies will certainly promote a more intelligent search for oil when failing supplies necessitate the location of the less easily exploited sources.

An investigation of unusual interest embraces the folded, faulted, and possibly oil-bearing belt that surrounds the Bearpaw Mountains, in Montana. Here the complexity, not of the observed facts but of the theoretical considerations that will determine a correct interpretation of underground structure—the shape and depth of folds and faults—is an illustration of the need for fundamental studies of the mechanics of the earth's crust.

In the study of metalliferous deposits two investigations, it is hoped, will throw light on the occurrence of gold and copper—one a critical study of the quartz veins of the Mother Lode, Calif., where apparently significant relations between ore shoots and barren veins have yet to be made out; the other a thorough study, surface and underground, of the Michigan copper country. The investigation in Michigan, begun by private companies actuated by enlightened self-interest, was carried out by them in a thoroughly scientific manner at great expense. Through their generosity the results of this work will be embodied in a report covering a much wider area. These results should be of great scientific and practical value.

In Nevada broad areal, structural, and economic studies in the Basin Range province continue to throw light on a little-known region, with the unexpected result that the older conception of widely prevalent simple block faulting is being supplanted by a conception of complicated overthrust faults and folds.

Investigation to discover deposits of potash has centered largely in southwestern Texas. Here the discovery of potash in well after well, the definite recognition of a potash-bearing mineral (polyhalite), the presence of potash of commercial grade, and the prospects of finding commercial deposits of potash similar to those of Germany and Alsace are all encouraging. In this work the Survey maintains cooperation with drillers and with oil companies operating in the region. Samples are collected and studied in the field and sent to Washington for analysis.

Among the papers published during the year is one entitled "The evolution and disintegration of matter," by F. W. Clarke (Professional Paper 132-D), which summarizes the progress of research that has led to the conclusion that the so-called chemical elements have originated by a definite evolutionary process and that this process may be reversible.

Three papers on coal, one on the Twentymile Park district of the Yampa coal field, Colorado (Bulletin 748), one on the Tullock Creek coal field, Montana (Bulletin 749), and one on the Raton coal field, New Mexico (Bulletin 752), were published during the year.

A progress report on a subsurface study of the Pershing oil and gas field, in Oklahoma (Bulletin 751-B), is of special interest.

The following reports, published during the year, are of special interest to the mining industry:

Geology and ore deposits of the Creede district, Colo. (Bulletin 718).

Geology and ore deposits of the Manhattan district, Nev. (Bulletin 723).

Origin of certain rich silver ores near Chloride and Kingman, Ariz. (Bulletin 750-B).

A report on the lime belt of Massachusetts and parts of eastern New York and western Connecticut was published as Bulletin 744.

A publication that will be welcomed by all geologists is a bibliography and index of geologic literature on North America from 1785-1918 (Bulletins 746 and 747).

WORK OF THE YEAR BY STATES

ALABAMA

Field work.—E. F. Burchard examined bauxite deposits in northwestern Alabama and conferred with geologists and mining men at Birmingham in connection with the compilation of additional geologic data on the iron ores of the Birmingham district. Charles Butts, in cooperation with the Geological Survey of Alabama, examined the Paleozoic areas of Alabama for a revision of the geologic map of the State. G. R. Mansfield examined a deposit of arsenopyrite near Cragford and conferred with its operators at Birmingham regarding its features. He also visited the plant of the Federal Phosphorus Co. at Anniston to study the method of manufacturing ferrophosphorus and phosphoric acid in the electric furnace.

Office work.—Work on a revised geologic map of Alabama, to be issued by the State in cooperation with the United States Geological Survey, is being carried on by L. W. Stephenson, C. W. Cooke, and Charles Butts, Messrs. Stephenson and Cooke determining the boundaries of the Upper Cretaceous, Tertiary, and Quaternary formations that crop out in the Coastal Plain and Mr. Butts studying the Paleozoic areas in the northern part of the State. G. R. Mansfield prepared a short report on the occurrence of arsenopyrite near Cragford. A paper on the Mississippian formations of the Tennessee Valley in northern Alabama is in preparation by Charles Butts. R. D. Mesler studied several collections of fossils from Alabama for comparison with similar faunas of other areas. M. N. Bramlette made a stratigraphic study of formations that may carry oil in northwestern Alabama.

ARIZONA

Field work.—N. H. Darton, in cooperation with the Arizona Bureau of Mines, made additional field studies in connection with the preparation of a geologic map of Arizona and a report on the physiography of the State. W. T. Thom, jr., in cooperation with H. I. Smith, of the United States Bureau of Mines, made an examination of the coal mines at the Keams Canyon Agency in northeastern Arizona for the Office of Indian Affairs, to determine the quantity of coal available there and the best method of mining it. H. A. C. Jenison continued his study of the geology of proposed dam sites on Colorado River in Boulder and Black canyons and of the valuation of mines and prospects adjacent to these sites. Edward Sampson made studies of the asbestos deposits near Globe. G. I. Finlay, assisted by Carle H. Dane, began work on the Four Corners project, their initial work being adjacent to the Gypsum Creek anticline.

Office work.—F. L. Ransome continued work on his detailed report on the geology and ore deposits of the Outman district and made some additions to his general report on the geology and ore deposits of Arizona. N. H. Darton compiled supplemental data for the cooperative geologic map of Arizona and made some progress on a bulletin on the physiography of the State. A report by Waldemar Lindgren on the ore deposits of the Jerome and Bradshaw Mountain quadrangles, Yavapai County, was completed and transmitted for publication. Edward Sampson prepared a review of a paper by A. M. Bateman on asbestos of Arizona. P. V. Roundy studied cuttings from a well drilled for oil in north-central Arizona, and K. C. Heald and J. G. Douglas studied cuttings from a

ell on Gypsum Creek. T. W. Stanton, G. H. Girty, and Edwin Kirk studied and reported on Cambrian, Carboniferous, and Cretaceous fossils from the State. E. F. Burchard and G. F. Loughlin made a study of materials from various sites in Arizona for the Bureau of Reclamation. W. T. Thom, jr., prepared, for transmission to the Office of Indian Affairs, a report giving the results of the examination of coal mines at the Keams Canyon Agency.

Publications.—Bulletin 750-B, Geologic Folio 217.

ARKANSAS

Field work.—H. D. Miser examined the manganese deposits of the Batesville district, Ark., inspected diamond-bearing rocks near Murfreesboro, conferred with operators of diamond mines at Murfreesboro, and collected fossil plants from a sandy shale near Gilham. H. D. Miser and C. S. Ross studied the Upper Cretaceous tuff and ash beds in southwestern Arkansas. Julia Gardner made a short field trip in Arkansas with the Shreveport branch of the Southwestern Geological Society. E. O. Ulrich and R. D. Mesler made studies of Paleozoic stratigraphy in the vicinity of Black Rock and Batesville.

Office work.—G. H. Girty continued work on his report on the fauna of the Morrow formation of Arkansas. C. S. Ross revised his paper on diamonds in Arkansas for publication in a report of the Smithsonian Institution and began to prepare a report on the volcanic tuffs and ash of the Upper Cretaceous rocks of southwestern Arkansas. H. D. Miser wrote a paper entitled "Diamond-bearing peridotite in Pike County, Ark.," for publication in the appendix to the annual report of the Smithsonian Institution for 1923. E. W. Berry has in preparation a report on additions to the Wilcox flora, which includes material from Arkansas. T. W. Stanton and G. H. Girty studied and reported on Cretaceous and Carboniferous fossils from the State. K. C. Heald and H. D. Miser studied drill cuttings from wells in southern and southwestern Arkansas for purposes of correlation.

Publication.—Geologic Folio 215.

CALIFORNIA

Field work.—F. E. Matthes completed a physiographic reconnaissance of the upper San Joaquin basin, Calif. W. S. W. Kew completed field work on the geology of the oil fields of southern Los Angeles County, revised his work in the San Pedro Hills and Inglewood Hills, and inspected fossil human remains found near Santa Barbara. L. F. Noble continued his studies of the San Andreas rift zone, investigated the Kramer borate deposits, and visited the plants of the Burnham Chemical Co. and American Trona Corporation, atearles Lake. W. P. Woodring and P. V. Roundy, assisted by H. W. Hoots, began a geologic study of Naval Reserve No. 1. Adolph Knopf, assisted by J. B. Nolan, resumed field work in the Mother Lode district in cooperation with the State.

Office work.—W. A. English submitted a report on the oil resources of the Santa Monica Hills (Bulletin 768). W. S. W. Kew completed reports on the San Pedro Hills, Los Angeles County, and on the geology and oil prospects of the Inglewood Hills district, studied data on the Inglewood earthquake, and completed a map of southern California. F. E. Matthes continued work on the physiography of the upper San Joaquin basin, revised a report on the origin of Yosemite Valley, and prepared other papers for outside publication. F. C. Perkins continued the preparation of a report on the bedrock of the Yosemite region. L. F. Noble prepared a report on the Kramer borate deposits and worked on a report on the San Andreas rift. W. H. Dall revised a report by J. Oldroyd on the Pleistocene fossils of San Pedro and reported on Pleistocene, Pliocene, and other fossils. Adolph Knopf prepared a paper on the Mother Lode for unofficial publication. Robin Willis submitted a report on the geology of the San Andreas fault from San Juan Bautista to the Cholame mines.

COLORADO

Field work.—J. D. Sears, assisted by P. C. Benedict and Q. D. Singewald, examined coal lands on Vermilion Creek, Colo., for land classification. Messrs. Sears, Mather, Gilluly, and Lusk did reconnaissance geologic mapping in northern Colorado. J. B. Eby continued examinations of the eastern part of theampa coal field and examined numerous tracts in adjacent areas for land classification. Mr. Eby visited and sampled mines at Mount Harris and, in

company with J. B. Reeside, jr., and C. E. Dobbin, made a trip through parts of northwestern Colorado and southern Wyoming to study the correlation of the coal-bearing and related formations. W. W. Boyer reexamined parts of the Grand Mesa coal field and examined tracts in La Plata, Las Animas, and Huerfano counties for land classification. He also inspected reported gas wells in San Luis Valley and the area covered by an oil-prospecting permit. C. D. Avery inspected drilling operations near Loveland and Fort Collins and collected well data in Denver. F. L. Hess examined platinum, uranium, and vanadium deposits in Colorado. W. H. Bradley began investigations of oil shale in Rio Blanco and Garfield counties. Adolph Knopf reexamined the Aspen district with a view to giving advice on the possible extension of mining.

Office work.—C. W. Cross, E. S. Larsen, C. S. Ross, and Kirtley Mather continued work on reports on the geology of the San Juan region. G. F. Loughlin continued the revision of the monographic report on the Leadville district that was left incomplete in 1917 by the death of Capt. J. D. Irving. Adolph Knopf completed a report entitled "Notes on the Aspen district." A report by E. T. Hancock on the economic geology of the Meeker quadrangle was revised by W. T. Thom, jr., assisted by J. B. Eby, and a report on the geology of the Axial and Monument Butte quadrangles (Bulletin 757), by E. T. Hancock, was revised by J. D. Sears, W. T. Thom, jr., and J. B. Eby. Mr. Eby nearly completed a report on the eastern part of the Yampa coal field and prepared a press notice on the Elkhead district, in that field. J. D. Sears revised his report on oil prospects in a part of Moffat County (Bulletin 751-G), and prepared a paper on the Browns Park formation and Bishop conglomerate for outside publication. J. B. Reeside, jr., prepared a report on the geology of Green River valley, Wyoming, Colorado, and Utah, for inclusion in a paper by R. R. Woolley on power sites and revised parts of a report on the Cretaceous and Tertiary formations of the western part of the San Juan Basin, in Colorado and New Mexico. T. W. Stanton made a preliminary report on Upper Cretaceous invertebrates from Colorado. K. C. Heald prepared a press bulletin entitled "Promising places for oil in Moffat County, Colorado," covering the Hamilton dome and Seeping Spring Gulch dome. G. H. Girty, F. H. Knowlton, and J. B. Reeside, jr., prepared paleontologic reports on material from Colorado.

Publications.—Bulletins 718, 748; press notices on coal in the Elkhead district of the Yampa coal field (No. 10653) and promising places for oil in Moffat County (No. 16037).

CONNECTICUT

Publication.—Bulletin 744.

DISTRICT OF COLUMBIA

Field work.—Laurence La Forge worked in the District of Columbia in connection with a geographic handbook of Virginia.

FLORIDA

Field work.—Julia Gardner continued a study of lower Miocene formations in Florida, chiefly in Walton and Washington counties, in informal cooperation with the State. C. W. Cooke examined some islands in Lake Worth with respect to age, for the General Land Office, and began geologic studies near Tallahassee and Marianna. J. T. Pardee supervised the classification of phosphate land in Polk, Marion, Hillsborough, Leon, and Jefferson counties.

Office work.—Julia Gardner completed the preparation of the third part of her paper on the mollusks of the Alum Bluff formation of Florida and began to prepare a paper on the mollusks of the lower Miocene reefs of Florida. W. H. Dall studied Pleistocene fossils from the State and completed, for the National Museum, a report on Pleistocene and recent fossils from Florida. C. W. Cooke prepared a report on the age of islands in Lake Worth for the Commissioner of the General Land Office. W. C. Mansfield began the preparation of a preliminary report on Pliocene and Pleistocene fossils from the Florida Everglades. J. T. Pardee is preparing reports on the classification of phosphate lands in Florida.

GEORGIA

Field work.—C. W. Cooke and Laurence LaForge made field studies of the physiographic features of Georgia.

Office work.—C. W. Cooke and Laurence LaForge began work on a co-operative report on the physiography of Georgia. Julia Gardner began to prepare a paper on the lower Miocene mollusks of Georgia and Florida.

IDAHO

Field work.—G. R. Mansfield, assisted at times by W. B. Lang, completed the geologic mapping and study of the phosphate deposits of the Portneuf quadrangle and of part of the Paradise Valley quadrangle, Idaho. Mr. Mansfield, accompanied by H. T. Stearns, also reviewed the Island Park irrigation project and the Empire irrigation district. At the request of the State Bureau of Mines and Geology Mr. Mansfield visited Moscow for conference on the geology of southeastern Idaho. In cooperation with the State Bureau of Mines C. P. Ross brought up to date the field work in the Hailey quadrangle. He also examined copper deposits near Salmon. E. F. Burchard inspected some iron-bearing mineral deposits in northern Idaho. F. C. Schrader examined molybdenite deposits at Rocky Bar.

Office work.—F. C. Calkins is preparing a report on the dam sites of the King Hill project. Edward Sampson and J. L. Gillson are writing a report on the geology of ore deposits near Lake Pend Oreille in cooperation with the State. A report by J. P. Buwalda on the oil and gas possibilities of southwestern Idaho was submitted to the Idaho Bureau of Mines and Geology for publication. T. W. Stanton, Edwin Kirk, G. H. Girty, and W. H. Dall prepared reports on Cambrian, Silurian, Jurassic, Ordovician, and Carboniferous fossils of Idaho. L. G. Westgate and C. P. Ross made progress on a co-operative report on the Hailey quadrangle. C. P. Ross submitted a report on the copper deposits near Salmon and prepared for unofficial publication a summary of the report. G. R. Mansfield prepared a paper on Tertiary planation in Idaho for publication in the *Journal of Geology* and a paper on the geography of southeastern Idaho for publication in the *Annals of the Association of American Geographers*. Mr. Mansfield made progress on reports on the Portneuf and Paradise Valley quadrangles. F. C. Schrader completed a paper on molybdenite in the Rocky Bar district (Bulletin 750-F). P. V. Roundy studied material from outcrops in the State in connection with his work in micropaleontology. J. T. Pardee, Kirk Bryan, and F. H. Knowlton prepared a paper on the relations of the Latah formation to the lavas of the Columbia Plateau. W. H. Dall continued the revision of a report on the remarkable fauna of the Idaho formation (*Professional Paper* 132-G).

ILLINOIS

Field work.—Frank Leverett studied glacial drift and glacial filling of the Mississippi River valley in western Illinois.

Office work.—G. H. Girty studied Carboniferous fossils from the State. Frank Leverett wrote a paper on glacial studies in western Illinois for presentation at a meeting of the American Association for the Advancement of Science.

Publication.—Geologic Folio 216.

INDIANA

Frank Leverett began studies of older glacial drift in southern Indiana and Ohio and carried on office work in connection with these studies.

IOWA

Field work.—W. C. Alden made brief examinations of glacial deposits of western Iowa in company with Dr. G. F. Kay, State geologist.

Office work.—G. H. Girty studied Carboniferous fossils from Iowa and revised a report on the typical Kinderhook fauna.

KANSAS

Field work.—W. W. Rubey, M. N. Bramlette, and N. W. Bass studied the geologic structure in parts of Kansas in cooperation with the State in a search for oil and gas, mapping Russell County and parts of northeastern Ellis County and southwestern Osborne County.

Office work.—W. W. Rubey and R. C. Moore identified microscopic fossils in well cuttings. G. H. Girty studied collections of Carboniferous fossils. T. W. Stanton reported on Cretaceous fossils. Frank Leverett wrote a paper on glacial deposits in Kansas for the American Association for the Advancement of Science. K. C. Heald prepared a paper on the stratigraphy of western Kansas for the American Association of Petroleum Geologists. W. W. Rubey and N. W. Bass completed a report on the oil and gas resources of Russell County. M. N. Bramlette worked on subsurface correlations in west-central Kansas.

KENTUCKY

Field work.—Charles Butts examined a proposed addition to a national forest in eastern Kentucky for the Forest Service and investigated the relation of the Sample sandstone of Breckenridge to the Bethel sandstone of western Kentucky and southern Illinois.

Office work.—Charles Butts prepared a report on Cumberland County for the State Geological Survey. G. H. Girty studied collections of Carboniferous fossils. M. N. Bramlette and K. C. Heald examined drill cuttings from a deep well near Bowling Green that indicate possible oil production from Ordovician rocks.

LOUISIANA

Field work.—M. I. Goldman collected specimens and data in Louisiana for his study of salt-dome cap rocks. Salt domes were visited by W. C. Mendenhall, David White, W. T. Thom, jr., and K. C. Heald.

Office work.—M. I. Goldman continued the study of salt-dome cap rocks and prepared a paper on their petrography for the American Association of Petroleum Geologists. E. W. Berry and Julia Gardner reported on fossil plants. M. N. Bramlette wrote a paper on bentonite in the Upper Cretaceous of Louisiana, to be read before and published by the American Association of Petroleum Geologists, and studied well samples. He also prepared a paper on the occurrence of volcanic rocks in the Cretaceous beds of Louisiana, for publication in the Bulletin of the American Association of Petroleum Geologists.

MAINE

Laurence LaForge examined the Portland quadrangle, Maine, in connection with his office work in the preparation of the Portland folio. J. S. Diller studied postglacial faulting in the Sunday River, White Cap, and Ice Cave mountains.

MARYLAND

Field work.—Work in Carroll and Frederick counties, Md., was carried on by A. I. Jonas and in Harford County by E. B. Knopf and Miss Jonas.

Office work.—A. I. Jonas continued work on a report on Carroll County for the Maryland Geological Survey and prepared a paper on the pre-Cambrian beds of the southwestern Piedmont region of Maryland for presentation at a meeting of the Geological Society of America. E. B. Knopf began a cooperative report on Harford County and prepared a paper on the physiography of eastern Pennsylvania and Maryland. W. C. Mansfield studied Pleistocene invertebrate fossils from Walles Bluff.

MASSACHUSETTS

Laurence LaForge did supplemental field work near Boston in connection with the Boston folio, which is practically completed. L. M. Prindle continued office work on the Taconic folio.

MICHIGAN

Field work.—Frank Leverett, in cooperation with the Michigan Geological Survey, completed the map of the Port Huron morainic system in Arenac, Iosco, and Ogemaw counties and was engaged in a cooperative study of the glacial deposits in Antrim County. He also completed cooperative field mapping of the Marshall quadrangle. E. O. Ulrich, in company with members of the Michigan Geological Survey, made a reconnaissance study of the Ordovi-

ian and Silurian formations of northern Michigan. B. S. Butler, assisted by W. S. Burbank, made studies in the Michigan copper district.

Office work.—Frank Leverett prepared a report on the surficial geology of Antrim and Ogemaw counties for the Michigan Geological Survey. E. O. Ulrich studied Ordovician and Silurian fossils collected in northern Michigan and compared faunas from the Collingwood and Maquoketa black shales.

MINNESOTA

E. F. Burchard held conferences with geologists and mining engineers at Minneapolis. Frank Leverett worked on a report on the Quaternary geology of Minnesota and bordering districts.

MISSISSIPPI

Field and office work.—E. F. Burchard examined the bauxite area of north-eastern Mississippi and prepared a report on it (Bulletin 750-G). M. N. Bramlette made a microscopic study of samples of rock from wells in north-eastern Mississippi and wrote a paper describing and correlating formations drilled through in two wells in the Paleozoic beds of northern Mississippi.

Publication.—Professional Paper 133.

MISSOURI

Field work.—E. O. Ulrich, assisted by R. D. Mesler, in association with members of the Missouri Geological Survey, examined the stratigraphy in southern Missouri. Frank Leverett studied the borders of the Mississippi Valley to determine the relations of the several glacial formations to drainage in the ice age and considered other related problems.

Office work.—C. E. Siebenthal continued the preparation of a report on the lead and zinc deposits of the Wyandotte quadrangle, Missouri-Oklahoma. Frank Leverett prepared a paper on glacial studies in Missouri for presentation at the meeting of the Geological Society of America. M. N. Bramlette made microscopic examination of well cuttings from Missouri. R. D. Mesler studied fossils from the Eminence and Forsyth quadrangles. G. H. Girty studied Carboniferous fossils and continued a report on the Pennsylvanian beds of the Joplin district.

MONTANA

Field work.—J. T. Pardee mapped glacial drift in Blackfoot, Jocko, and Flathead valleys, Mont., reexamined the Melrose phosphate field and some adjacent territory, and examined the Morrison potash claim for land classification. C. E. Dobbin and N. W. Bass completed an examination of the Forsyth coal field. A. J. Collier examined Devonian rocks in the Little Rocky Mountains that may be a primary source of oil in northern Montana, and, with R. G. Lusk, completed work southeast of the Sweetgrass region. W. T. Thom, jr., examined the Taylor Fork coal field and, with C. E. Dobbin, studied the Lance and Fort Union formations in eastern Montana and western North Dakota. S. H. Cathcart began work in the Jardine district. J. B. Reeside, jr., and C. E. Dobbin studied the stratigraphy between Billings and Forsyth. N. W. Bass mapped part of the Tongue River coal field for land classification. A. A. Baker, assisted by John B. Stone, continued an examination of the Tongue River coal field. W. T. Lee extended into the Big Horn Basin his work on the correlation of Mesozoic formations of Wyoming. Frank Reeves and W. S. Burbank studied the Bearpaw Mountains. In June Sidney Paige visited this party.

Office work.—A report on the northern Big Horn district by G. F. Moulton was transmitted for publication. A revised report on the Tullock Creek coal field (Bulletin 749) by G. S. Rogers and Wallace Lee was transmitted for publication. W. T. Thom, jr., prepared a report on coal in the vicinity of Taylor Fork (Madison Range) for land classification, continued work on reports on the Judith River and Poplar coal fields and the coal lands in the Crow Indian Reservation, and prepared a press notice on the discovery of oil in Lake Basin. K. C. Heald and W. C. Mendenhall prepared a memorandum to the Commissioner of Indian Affairs on the adequacy of test wells drilled on the Milk River anticline, in the Blackfeet Reservation. W. C. Alden continued work on the Cenozoic history of eastern Montana and wrote papers

on this subject and on the physiographic development of the Great Plains for presentation at the meeting of the Geological Society of America. He also prepared a popular geologic story of the great overthrust in Glacier National Park for outside publication. W. T. Thom, jr., assisted by A. A. Baker, revised and submitted for publication a report by C. M. Bauer on the Ekalaka lignite field (Bulletin 751-F). M. I. Goldman studied phosphate from the Ryan-Stephenson well. K. C. Heald was engaged in preparing a report on the Ingomar dome and prepared a paper for the Great Falls Leader on the Geological Survey and the Montana oil fields. W. T. Lee presented before the Society of Economic Geologists a paper on the continuity of some oil-bearing sands in Montana and Wyoming. N. W. Bass prepared a press notice on coal in the Tongue River valley. J. T. Pardee prepared a map of the glacial drift and associated deposits in the Jocko and Flathead valleys and a map, for exhibition before the Geological Society of America, showing the glacial and physiographic geology of the northern Rocky Mountains, and began the preparation of a report on glaciation and gold-bearing gravels in the Pioneer district. He also prepared a report on the Morrison potash claim, near Whitehall, Mont., for land classification and completed a report on the geology of the Melrose phosphate field (Bulletin 750-H). A. J. Collier began work on a report on the geology and oil resources of the Sweetgrass arch and submitted for publication a report on the Scooby lignite field (Bulletin 751-E). G. H. Girty, T. W. Stanton, Edwin Kirk, and J. B. Reeside, jr., examined and reported on Carboniferous, Devonian, Jurassic, and Cretaceous fossils. C. E. Dobbin and N. W. Bass completed a report on the Forsyth coal field for land classification, and Mr. Dobbin prepared a press notice covering coal lands along the projected Armells Creek branch of the Northern Pacific Railway. W. T. Thom, jr., and C. E. Dobbin prepared a paper on the stratigraphy of the Cretaceous-Eocene transition beds in eastern Montana, for presentation at a meeting of the Geological Society of America. Frank Reeves prepared a report on the oil and gas resources of the faulted area south of the Bearpaw Mountains (Bulletin 751-C) and prepared for the Geological Society of America a paper on the structure of the Bearpaw Mountains. B. C. Renick prepared a paper entitled "Some problems of ground water and associated natural gas."

Publications.—Professional Paper 132-B; Bulletin 749; press notices, "New oil field in Lake Basin, Mont., indicates artesian control of oil and gas accumulation" (No. 17340); "Oil and gas prospects north of the Pryor Mountains, Mont." by G. F. Moulton (No. 16001); "Coal in Tongue River valley, Mont." (No. 16748); "The Rosebud coal bed south of Forsyth, Mont." (No. 16925).

NEBRASKA

J. A. Douglas examined microscopically drill cuttings from a deep well near Lakeside.

NEVADA

Field work.—T. W. Stanton studied the Mesozoic stratigraphy of the Spring Mountain Range, in the Las Vegas quadrangle. L. G. Westgate, assisted by J. L. Gillson, continued a study of the Pioche mining district. H. G. Ferguson and S. H. Cathcart continued the mapping of the Tonopah and Hawthorne quadrangles, in which T. W. Stanton reviewed the marine Triassic and Lower Jurassic sections.

Office work.—D. F. Hewett began the preparation of a report on the Goodsprings mining district and wrote a paper on dolomitization near Goodsprings for the Geological Society of Washington. He transmitted for publication a report on magnesite alum near Fallon (Bulletin 750-E). G. H. Girty studied Carboniferous fossils; T. W. Stanton studied Mesozoic, Jurassic, and Triassic fossils; F. H. Knowlton reported on fossil plants near Mina; and Edwin Kirk studied Ordovician, Cambrian, Silurian, and Devonian fossils. H. G. Ferguson and S. H. Cathcart wrote jointly a paper on mountain structure in western Nevada for the Geological Society of Washington and began the preparation of a report on the Hawthorne and Tonopah quadrangles. H. G. Ferguson revised a report on the Manhattan district (Bulletin 723). Adolph Knopf revised a report on the Rochester district (Bulletin 762).

Publication.—Bulletin 723.

NEW HAMPSHIRE

J. S. Diller made glacial studies in the White Mountains and prepared field maps of the White Mountains and vicinity. Arthur Keith continued the preparation of a geographic handbook of New England.

NEW JERSEY

W. S. Bayley studied in the field the pre-Cambrian geology of the Delaware Water Gap and Easton quadrangles in connection with studies of magnetite deposits, and began the preparation of a paper on pre-Cambrian geology and ore deposits of these quadrangles.

NEW MEXICO

Field work.—N. H. Darton extended his work in the Red Beds area to supplement the knowledge of the potash-bearing region of New Mexico. J. B. Reeside, Jr., mapped the Ute and Barker Creek domes, Southern Ute Indian Reservation, San Juan County, and mapped the Hogback anticline near Shiprock, at the request of the Office of Indian Affairs.

Office work.—T. W. Stanton reported on Upper Cretaceous fossils. G. H. Girty studied Carboniferous fossils. N. H. Darton redrew the contours of the geologic map of New Mexico. K. C. Heald prepared memoranda on the oil resources of the Navajo Reservation for the commissioner of the reservation.

B. Reeside, Jr., revised a manuscript on the Cretaceous and Tertiary formations of the western part of the San Juan Basin, Colorado and New Mexico. He also prepared reports on the Hogback anticline and the Ute and Barker Creek domes, which were transmitted to the Office of Indian Affairs.

Publications.—Bulletins 752, 760—A.

NEW YORK

Field and office work.—L. M. Prindle continued field studies of the geology of the Hoosick and Berlin quadrangles, N. Y., and office work on the Taconic geologic folio. W. H. Dall studied two large collections of fossils sent from the Brooklyn museum.

Publication.—Bulletin 744.

NORTH CAROLINA

Field work.—C. S. Ross revisited the Ore Knob copper mine, in Ashe County, N. C. C. W. Cooke collected Miocene fossils near Jacksonville.

Office work.—E. W. Berry began the preparation of a manuscript on the Eocene flora of North Carolina. L. B. Kellum completed a paper on the paleontology and stratigraphy of the Castle, Hayne, and Trent marls of North Carolina.

NORTH DAKOTA

Field work.—W. T. Thom, Jr., and C. E. Dobbin made an extensive reconnaissance through the lignite fields of western North Dakota to discover the relations of the coal-bearing formations.

Office work.—W. T. Thom, Jr., assisted by J. B. Eby and A. A. Baker, revised a report by C. J. Hares on the geology and lignitic resources of the Marmarth field, in southwestern North Dakota, and submitted it for publication. W. T. Thom, Jr., and C. E. Dobbin completed a paper on the Cretaceous-Eocene transition beds, Dakota-Montana. J. B. Reeside, Jr., reported on Cretaceous basins.

OHIO

Frank Leverett began field studies of the older glacial drift in southern Indiana and Ohio. G. H. Girty reported on Carboniferous fossils.

OKLAHOMA

Field work.—H. D. Miser was engaged in field work required for a geologic map of Oklahoma. A. F. Melcher collected data on the production and texture of producing oil sands in the Tonkawa and Burbank fields. K. C. Heald, at the request of the Commissioner of Indian Affairs, attended the sale of Osage leases at Pawhuska. David White, K. C. Heald, and H. D. Miser participated at a conference at Houston about work on the Oklahoma geologic map and subsurface work in Oklahoma for which the State legislature has made an appropriation.

Office work.—H. D. Miser compiled data for a geologic map of Oklahoma. In response to a request from the Office of Indian Affairs K. C. Heald and W. T. Thom, Jr., considered the possible yield of oil from 1,328 undrilled oil leases in the Osage Reservation and prepared recommendations regarding them. P. V. Roundy prepared data for use at the sale of Osage leases at Pawhuska and studied outcrop material and well cuttings from Oklahoma.

A. F. Melcher examined chunk samples of oil and gas sands of the Tonkawa and Burbank districts and prepared a paper on the application of production-porosity curves to the Burbank field for publication in the Bulletin of the American Association of Petroleum Geologists. A part of a diamond-drill core from the Tonkawa field is being studied in an attempt to establish a type stratigraphic section for western Oklahoma. G. H. Girty revised his report on the fauna of the Morrow formation of Arkansas and Oklahoma. T. W. Stanton identified Cretaceous invertebrates, G. H. Girty studied Carboniferous fossils, W. H. Dall reported on Pleistocene fossils, and E. O. Ulrich prepared reports on the Stanley, Jackfork, and Caney formations and reported on fossils from a deep well in Oklahoma. G. H. Girty and P. V. Roundy worked on a report on the Moorefield fauna of northeastern Oklahoma. C. E. Siebenthal is preparing a report on the lead and zinc deposits of the Wyandotte quadrangle, Missouri-Oklahoma.

Publication.—Bulletin 751-B.

OREGON

Field work.—W. H. Bradley examined the deposits in Goose Lake and Upper Klamath Lake in a study of the origin of oil shale.

Office work.—C. P. Ross revised a report on the Wallowa Mountains. F. C. Calkins continued the preparation of a report on dam sites in Idaho and Oregon for the Bureau of Reclamation. W. S. W. Kew prepared a report on the occurrence of oil shale near Medford, a copy of which was sent to the Oregon Corporation Commission.

Publication.—Geologic Folio 218.

PENNSYLVANIA

Field work.—Field conferences were held in Pennsylvania by Sidney Paige, Adolph and E. B. Knopf, and Florence Bascom relative to mapping the Quarryville and McCalls Ferry quadrangles and adjoining areas. Mrs. Knopf studied the pre-Cambrian rocks of Pennsylvania near Coatesville and Oxford. A. F. Melcher inspected pressure apparatus at the University of Pittsburgh and visited the Bradford oil field. G. W. Stose worked in the Lancaster, New Holland, Conesville, Honeybrook, Phoenixville, and Doylestown quadrangles. W. S. Bayley worked in the Easton and Delaware Water Gap quadrangles in a study of the pre-Cambrian magnetite-bearing rocks. David White, with O. C. Postley and A. M. Farrell, studied the stratigraphy of the Brookville coal in the vicinity of the type locality. W. C. Mendenhall, with other members of the Survey, made a trip through central and southern Pennsylvania and southwestern New England to obtain a general idea of the geologic succession.

Office work.—E. B. Knopf and A. I. Jonas continued work on a report on the Quarryville and McCalls Ferry quadrangles, and Miss Jonas began the preparation of a report on the Lancaster and New Holland quadrangles. Mrs. Knopf presented before the Geological Society of America a paper on the physiography of eastern Pennsylvania and Maryland. W. S. Bayley began the preparation of a paper on the pre-Cambrian geology and ore deposits of the Easton and Delaware Water Gap quadrangles. G. H. Girty studied Carboniferous fossils. E. O. Ulrich reported on fossils of Trenton age, and Edwin Kirk reported on Devonian fossils. G. W. Stose completed and transmitted to the State geologist a report on the economic geology of Adams County. He also prepared and read before the Geological Society of America a paper on a new type of structure in the Pennsylvania Appalachians. Charles Butts prepared papers on the Leyahanna limestone in southwestern Pennsylvania and on the Birmingham overthrust fault in the Lynne quadrangle for the Geological Society of America. He also prepared a map of a small part of the Standingstone quadrangle for R. S. Bassler.

SOUTH CAROLINA

Field work.—G. R. Mansfield studied parts of the phosphate field of South Carolina.

Office work.—J. B. Reeside, Jr., read proof of a paper on a new Eocene nautiloid from South Carolina, to be published as No. 2518 of the Proceedings of the United States National Museum.

SOUTH DAKOTA

Office work.—T. W. Stanton reported on Upper Cretaceous fossils from South Dakota for the State geologist. J. B. Reeside, Jr., reported on Cretaceous

ossils collected by C. E. Dobbin in western South Dakota and studied Jurassic fossils collected near Rapid City by W. T. Lee. G. H. Girty reported on some Carboniferous fossils. W. T. Thom, jr., prepared a joint paper with C. E. Dobbin on the Cretaceous-Eocene transition beds in the Dakotas and Montana. J. H. Darton spent some time condensing the text of the Black Hills folio.

TENNESSEE

Field work.—E. O. Ulrich, assisted by R. D. Mesler, studied the stratigraphy of the Tellico formation in eastern Tennessee. E. F. Burchard continued studies of brown iron ores in west-middle Tennessee in cooperation with the Tennessee Geological Survey. Charles Butts reviewed the geologic mapping of a part of the Friendsville marble belt.

Office work.—T. W. Stanton revised Bruce Wade's manuscript on the Upper Cretaceous fauna of Coon Creek (Prof. Paper 137). E. O. Ulrich, assisted by R. D. Mesler, prepared and compared old and new collections of fossils from beds of marble in eastern Tennessee in order to settle a controversy regarding the identification of the Meadow marble and to correct the mapping of its boundaries. In preparing a paper on additions to the flora of the Wilcox group, E. W. Berry studied material from this group in Tennessee. He also reported on Eocene plants from Tennessee. G. H. Girty studied Carboniferous fossils. E. F. Burchard began the preparation of a cooperative bulletin on the brown iron ores of west-middle Tennessee. D. F. Hewett continued the preparation of a paper entitled "Relation of manganese oxides in Virginia and Tennessee." Charles Butts revised the geologic map and profile sections of the Friendsville marble area.

TEXAS

Field work.—W. B. Lang visited wells in the western Texas potash area and procured samples of rock borings. Julia Gardner continued the study of the lower Eocene formations of the State. M. I. Goldman collected specimens and data for a study of the salt-dome cap rocks in the Gulf coast region of Texas and Louisiana. K. C. Heald held a field conference with Receiver Delano at Wichita Falls.

Office work.—In conjunction with the Director of the Survey, G. R. Mansfield prepared for the Journal of the American Bankers' Association an article entitled "Potash—the key to prosperous agriculture." Mr. Mansfield investigated the cost of core drilling in Texas in response to a request from Senator Sheppard for an estimate of the amount required to make tests of cores of wells drilled for potash in western Texas and with W. B. Lang attended hearings on Senator Sheppard's potash bill before the Senate Committee on Agriculture and the House Committee on Mines and Mining. In connection with the search for potash W. B. Lang conferred with members of the Survey and the Bureau of Mines, compiled field data, and drafted maps of an area in Texas. A press notice on potash in western Texas was prepared by David White and George Steiger. Work on salt-dome cap rocks was continued by M. I. Goldman, who prepared a paper entitled "The petrography of salt-dome cap rocks," for presentation at the Houston meeting of the American Association of Petroleum Geologists. G. H. Girty, P. V. Roundy, and M. I. Goldman prepared a paper on the microfauna of the Mississippian formations of San Saba County, Tex., which includes a study of the age and correlation of the Ellenburger and Mississippian limestone contact. G. H. Girty worked on a report on the basal Bend fauna of Texas, which he is preparing with P. V. Roundy, and studied Carboniferous fossils from the State. E. W. Berry continued the study of fossil plants in connection with his manuscript on additions to the Wilcox flora and studied collections of fossil plants from the State. Julia Gardner prepared a report on the fossiliferous marine Wilcox beds of Texas for outside publication and continued work on her report on the Eocene formations of Texas. Miss Gardner studied Texas fossils in the Aldrich collection at Johns Hopkins University, Baltimore, Md., and made determinations of small collections from the Butler dome in Anderson County. L. W. Stephenson continued work on his paper entitled "Summary of the stratigraphy of the Gulf series (Upper Cretaceous) formations of Texas between Austin and the Rio Grande." E. O. Ulrich determined the horizons of fossils in a deep well in Texas; T. W. Stanton reported on Comanche fossils; W. H. Dall reported on fossils from the State; and P. V. Roundy examined outcrop material and drill cuttings. K. C. Heald prepared a statement regarding the oil, gas, and coal resources of southwestern Texas for the Interstate Commerce Commission and, with David

White, attended hearings on the West Columbia salt dome before the income-tax division of the Treasury Department.

Publications.—Professional Papers 126, 132-D; press notice on potash in western Texas (No. 16953).

UTAH

Field work.—F. L. Hess revisited carnotite fields in Utah and, with V. C. Heikes, examined arsenic and tungsten deposits in the Clifton district. G. I. Finlay and Carle H. Dane made a reconnaissance map of an area along Gypsum Creek. E. M. Spieker, assisted by A. A. Baker and later by D. J. Fisher, completed an examination of the Wasatch Plateau coal field and coal-bearing areas in Salina Canyon and near Horse Canyon and Crescent.

Office work.—E. M. Spieker and A. A. Baker continued the preparation of a report on the Wasatch Plateau coal field and transmitted for publication reports on coal in the Salina Canyon, near Horse Canyon, and near Crescent, Utah. Messrs. Spieker and Baker prepared reports for classification of lands. G. H. Girty began the preparation of a report on the Triassic faunas of Utah. H. D. Miser prepared a popular article on the exploration of the San Juan Canyon, a tributary of the Colorado, by K. W. Trimble and himself. He also completed a report on anticlinal structure in San Juan County (Bulletin 751-D). J. B. Reeside, jr., prepared the first draft of a popular report on the geology of Green River valley, Wyoming, Colorado, and Utah, for inclusion in a paper by R. R. Woolley on power sites. He also completed an examination of Mesozoic and Tertiary fossils collected by E. M. Spieker in central Utah. F. H. Knowlton reported on material from the Mesaverde formation of Utah for Mr. Spieker. F. R. Clark completed and transmitted for publication a report on the Sunnyside, Wellington, and Castlegate quadrangles. F. C. Calkins continued the preparation of a report on the general geology of the Cottonwood district by B. S. Butler and himself.

Publications.—Professional Paper 132-C, Bulletin 750-A.

VERMONT

L. M. Prindle spent some time in field work on the geology of the Taconic quadrangle and in the office continued the preparation of the Taconic folio.

VIRGINIA

Field work.—M. R. Campbell, assisted at times by W. T. Thom, jr., completed a study of the Valley coal fields of Virginia, made in cooperation with the Virginia Geological Survey. E. O. Ulrich and R. D. Mesler studied the stratigraphy of areas in southwestern Virginia. W. C. Mansfield studied Tertiary deposits along James River above and below Claremont and in the "Northern Neck," mainly north of Warsaw.

Office work.—M. R. Campbell worked on a cooperative report on the Valley coal fields of Virginia. He also prepared a press notice on these fields. W. C. Mansfield continued the preparation of a report on the Miocene stratigraphy of Virginia. E. O. Ulrich began work on the faunas of the Murat limestone of Virginia, undertaken particularly to determine the age of the Holston marble of Tennessee. Mr. Mesler worked on collections of Ordovician fossils. G. W. Stose prepared a paper on iron carbonate in Clinton ores of southwestern Virginia for publication in *Economic Geology* and one entitled "The black-shale problem of Virginia." He also read proof of a report on Wise County to be published by the Virginia Geological Survey. Charles Butts reported on samples of well borings from the Rose Hill well. Edwin Kirk reported on Devonian fossils. K. C. Heald wrote a paper on Lee County for out-of-publication. D. F. Hewett prepared a paper entitled "Relation of manganese oxide in Virginia and Tennessee."

Publications.—Press notices on the Valley coal fields of Virginia and oil in Lee County, Va.

WASHINGTON

Field work.—E. F. Burchard conferred with geologists and mining engineers in Spokane and examined iron-bearing deposits in northern Washington. J. T. Pardee studied Miocene shale and associated rocks for a report being prepared by him, F. H. Knowlton, and others.

Office work.—F. H. Knowlton studied the flora of the Puget group of Washington and described new fossil plants for a paper on the age of strata inter-

with the Columbia lava at Spokane, Wash., and Coeur d'Alene, Idaho. F. Pardee prepared an introduction to this paper. W. H. Dall reported collections of Pleistocene invertebrate fossils. T. W. Stanton studied Lower Pleistocene invertebrate fossils from northwestern Washington.

WEST VIRGINIA

work.—By invitation of the State geologist, David White joined a party from the West Virginia Geological Survey early in May for a reconnaissance of the Mississippian formations in several counties of the north of the Chesapeake & Ohio Railway. Fossil plants were collected from strata representing the Pocono, Greenbrier, and Mauch Chunk divisions. The expense of the trip was borne by the State Survey, which is in close cooperation with the Federal Survey, a comprehensive report on the geology, areal geology, and paleontology of the Mississippian formations in the southern half of the State. The invertebrate fossils collected will be described by G. H. Girty and the plants by David White.

work.—G. H. Girty studied Carboniferous collections from West Virginia.

WISCONSIN

work.—E. O. Ulrich studied the Paleozoic stratigraphy of Wisconsin and conferred with the State geologist.

work.—E. O. Ulrich studied Ordovician and Silurian fossils from Wisconsin and prepared collections of Wisconsin Cambrian fossils for study. Leverett worked on reports in hand.

WYOMING

work.—J. B. Reeside, jr., and C. E. Dobbin made stratigraphic and geologic studies of the Powder River basin, Wyo., giving particular attention to the Fox Hills formation and its relations to the Pierre shale and the Lance formation. They made reconnaissance trips near Baggs, Rawlins, Walcott, and in the Big Horn Basin. Edwin Kirk studied the Rocky Mountain Devonian rocks. F. L. Hess and C. W. Henderson visited reported oil and placer gold deposits in the Medicine Bow Mountains. W. C. Alden studied the glacial deposits and the physiography in Park, Big Horn, and Washakie, Natrona, Johnson, Sheridan, and Fremont counties. They worked between Thermopolis, Wyo., and Bridger, Mont., in a study of the Tertiary formations. J. D. Sears, assisted by P. C. Benedict and Quentin Alden, examined coal lands on Vermillion Creek, in southern Baxter Basin, Carbon County, for land classification and did some work in the Baxter Basin field. John D. Northrop examined tracts in the Arapaho coal field in the southern Big Horn Basin coal field for land classification. W. H. Bass, assisted by Carl H. Dane, mapped and studied oil shales of northern Carbon County. A. J. Collier, C. D. Avery, and E. T. McKnight mapped oil shales in southern Wyoming. W. H. Bradley and C. E. Erdmann made a geological reconnaissance northwest of Rock Springs. J. B. Eby worked in the Arapaho coal field and examined the stratigraphy and structure of parts of western Colorado and southern Wyoming with J. B. Reeside, jr., and Dobbin. At the request of the Bureau of Mines W. T. Thom, jr., examined coal lands in the vicinity of Gillette. N. W. Bass and W. T. Thom examined miscellaneous tracts covered by applications for prospecting. C. D. Avery collected information about oil wells at Casper, Glenrock, Torrington, Guernsey, Cheyenne, Laramie, Rawlins, and Medicine. W. W. Rubey, assisted part of the time by H. W. Hoots, Alexander Hoff, M. N. Bramlette, and F. A. Melton, continued studies in several of the Black Hills rim.

work.—W. T. Thom, jr., prepared a report for the Bureau of Mines on coal lands near Gillette. W. T. Thom, jr., J. D. Sears, J. D. Northrop, and Bass reported on tracts examined for land classification. F. H. Knowlton reported on fossil plants from central Wyoming and studied fossil plants in the Rock Springs coal group of Wyoming. W. C. Alden prepared a paper on the physiographic development of the northern Great Plains for the Geological Society of America. A. J. Collier wrote a press notice on oil and gas of the North Casper Creek anticline, and K. C. Heald prepared a memorandum concerning its possibilities as a naval oil reserve. W. W. Rubey did data relative to the Dry Creek anticline for land classification. P. V. Work worked with K. C. Heald on maps of the Teapot dome and studied out-

crop material. G. H. Girty studied Carboniferous fossils. J. D. Sears revised his report on the geology and oil and gas prospects in a part of Moffat County, Colo., and southern Sweetwater County, Wyo. (Bulletin 751-G). D. F. Hewett completed the report on the geology and the oil, gas, and coal resources of the Oregon Basin, Meeteetse, and Grass Creek Basin quadrangles. A press notice on the possible oil in deep sands near the Osage field in Wyoming, including a structure contour map and description of the Pump Creek anticline, was prepared by C. R. Longwell and W. W. Rubey. K. C. Heald studied well cuttings from a deep well near the Osage field and from a deep well in Goshen Hole. W. C. Alden continued the preparation of a report on the Cenozoic history of eastern Montana and Wyoming, which includes an account of the Tertiary and Pleistocene bench gravels and glacial phenomena. W. T. Lee prepared a report on the continuity of some of the oil-bearing sands of Wyoming and Montana for presentation before the Society of Economic Geologists. J. B. Reeside, jr., prepared a popular report on the geology of the Green River valley, in Wyoming, Colorado, and Utah, for inclusion in a paper by R. R. Woolley on power sites. K. C. Heald outlined a research problem for Edwin Binney, of Yale University, and started him on his work, which involves a study of the occurrence of gas in the Oregon Basin and Garland domes. J. D. Sears began the preparation of a report on the Baxter Basin gas field and submitted a preliminary report on the productive area of the field for land classification. W. W. Rubey prepared a report on the Osage, Moorcroft, and Wakeman region for land classification. He also compiled data relative to the Dry Creek anticline for land classification. Work on a report on the Black Hills rim was advanced by W. W. Rubey, H. W. Hoots, and Alexander Stepanoff. W. H. Bradley prepared a paper on fossil caddis-fly cases from the Green River formation of Wyoming for outside publication; also a paper on an oil shale and its microorganisms from the Fuson formation of Wyoming. He also began the preparation of a report entitled "A stratigraphic study of a shore phase of the Green River formation in northwestern Sweetwater County, Wyo." Mr. Bradley also wrote a paper on the calcareous alga reefs of the Green River formation for outside publication. K. C. Heald studied critically the relation of oil and gas to the structure of the Teapot dome and advised Government counsel dealing with this naval reserve. He conferred with Commissioner Stewart in Casper and Cheyenne regarding Naval Reserve No. 3. K. C. Heald, G. W. Stose, and T. W. Stanton completed the compilation of a geologic map of Wyoming. The character and the distribution of the Frontier formation were studied by G. K. Drach and K. C. Heald. J. B. Reeside, jr., reported on Cretaceous and Jurassic fossils from the western rim of the Black Hills and other places. Edwin Kirk reported on Cambrian fossils from Wyoming.

Publications.—Professional Paper 132-C; press notices on the possibility of finding oil in deep sands near the Osage field and the North Casper Creek anticline—a possible new gas and oil field.

ALASKA

In cooperation with the Alaskan mineral resources branch, F. H. Knowlton and W. H. Dall reported on fossil plants and invertebrate fossils from northern Alaska. Edwin Kirk prepared a paper on *Harpidium*, a new genus of pentameroid brachiopods from the Silurian rocks of southeastern Alaska. Messrs. Roundy, Stanton, Kirk, Girty, Knowlton, and Reeside reported on Carboniferous, Mesozoic, Paleozoic, Ordovician, Silurian, Devonian, Jurassic, and Cretaceous fossils.

CANADA

P. V. Roundy studied Ostracoda from Canada. G. H. Girty worked on Carboniferous fossils. Edwin Kirk prepared a manuscript on the stratigraphy of the Beaverfoot, Brisco, and Stanford ranges, British Columbia. Julia Gardner worked on a report on the gastropods of the Mons formation and prepared reports and revised manuscripts on the Paleozoic fauna of British Columbia for Secretary Walcott of the Smithsonian Institution. T. W. Stanton prepared a report on some Upper Cretaceous fossils from Alberta. W. H. Dall read proof of a short report to the Canadian Government on Oligocene material from the Arctic coast. F. L. Hess examined nickel and other mines in Canada at his own expense. Edwin Kirk was detailed to work with Secretary Walcott on the Upper Paleozoic fauna of British Columbia. W. H. Dall reported on fossils sent in by the Provincial Museum, Victoria, British Columbia.

WEST INDIES

W. H. Dall reported on fossils from the Bahama Islands and from Bermuda. V. C. Mansfield identified Eocene and later fossils from Jamaica and prepared for publication a report on Miocene gastropods from Trinidad. W. P. Woodring prepared a report on Jamaican fossils for Dr. C. A. Matley, Government geologist of Jamaica, and helped in the publication and distribution of a report on the geology of the Republic of Haiti.

MEXICO AND CENTRAL AMERICA

Julia Gardner examined fossils from Mexico. C. W. Cooke cataloged types of Mexican fossils. W. H. Dall furnished information on fossils from Lower California to Eric Jordan. J. B. Reeside, jr., examined Cretaceous fossils collected in Tehuantepec by J. T. Singewald. T. W. Stanton identified invertebrates of Comanche age from Guatemala. W. H. Dall reported on a small lot of Miocene fossils for W. C. Mansfield, who made a preliminary report on Oligocene and later fossils from Guatemala. W. C. Mansfield prepared a report on fossils from the Province of Chiriqui, Panama. W. P. Woodring attended to correspondence concerning geologic work in Central America.

SOUTH AMERICA

W. C. Mansfield prepared preliminary reports on Tertiary and Quaternary fossils from Colombia and Ecuador. J. B. Reeside, jr., examined collections of Mesozoic fossils from Colombia and examined and identified Cretaceous and Tertiary fossils from Patagonia. W. H. Dall reported on fossils from Peru, Venezuela, Brazil, Uruguay, and Patagonia.

AUSTRALIA AND PACIFIC ISLANDS

T. W. Vaughan, A. H. Brooks, and H. E. Gregory attended conferences of the Pan-Pacific Science Congress at Melbourne and Sydney, Australia, and made some geologic examinations. T. W. Vaughan visited museums and inspected Tertiary formations in New Zealand. W. H. Dall reported on fossils from Palmyra Island for the Bishop Museum at Honolulu and on fossils from the Fiji Islands. W. C. Mansfield prepared a report on fossils from Vavau, Tonga Islands, revised his manuscript on the Tertiary fossils of the Fiji Islands, and prepared a report on fossils from quarries near Suva, Viti Levu, and an annotated bibliography on the geology of the Fiji Islands. W. H. Dall reported on Hawaiian fossils and prepared illustrations for a monograph on Hawaii. W. C. Mansfield made a generic list of Miocene and later fossils collected by E. F. Burchard in the Philippine Islands.

ASIA

G. H. Girty worked on Carboniferous fossils from China. W. H. Dall reported on fossils from China for Prof. Arthur Jacot, Hsu Liu University. F. H. Knowlton studied and prepared a report on fossil plants from central China. T. W. Stanton studied Chinese Mesozoic invertebrates. W. H. Dall reported on fossils from Japan and from the Persian Gulf.

EUROPE

W. H. Dall reported on fossils sent in by Dr. N. H. Odhner, of the Royal Academy, Stockholm, Sweden, on fossils from Shrewsbury, England, and on Miocene fossils from Iceland.

DIVISION OF MINERAL RESOURCES

The work of the division of mineral resources was carried on during the year with little change in organization or program. On May 23, 1924, G. F. Loughlin, geologist in charge, was relieved of duty as chief of the division in order to assume charge of the section of metalliferous deposits in the division of geology, and Frank J. Katz was appointed geologist in charge. On November 11, 1923, the division suffered the loss of one technical employee through the resignation of H. A. C. Jenison, specialist in copper and manganese. F. G. Tryon, who had been transferred

to the United States Coal Commission during the preceding year, was reinstated in the division on September 23, 1923, and was furloughed on June 24, 1924, for about two months, to permit him to make special studies in Europe under the auspices of the Institute of Economics. The clerical staff was reduced by the resignation of one member and the transfer of two to other offices. This reduction was partly offset by the appointment of one clerk, who was assigned to duty at the branch office of the Survey at Denver. During the year the division employed, for short periods, nine clerks on temporary appointments in the Washington office and two on temporary appointments in the branch offices.

The work of the division continued to be hampered by inadequacy of personnel, working space, and funds for field canvasses and other investigations.

Cooperation with the Bureau of the Census in the census of manufactures for 1923 was maintained according to the program laid down for 1921, as outlined in the Director's report for the fiscal year 1922. Joint canvasses under this arrangement were essentially complete at the end of the fiscal year. The division also undertook, for the Bureau of the Census and the Forest Service, a canvass of coal and metal mines to obtain data on the use of timber underground in mines.

Cooperation with State geological surveys was continued. During the year the cooperating States were Alabama, Florida, Georgia, Illinois, Iowa, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Oregon, Texas, Virginia, Washington, and Wisconsin.

The metals section limited its work to the routine of collecting and publishing statistical matter relating to the mine, smelter, and refinery output of metals and to performing a small amount of work in cooperation with the Senate Commission on Gold and Silver Inquiry. The nonmetals section also was engaged almost entirely in routine statistical inquiries and compilations, though in cooperation with the division of geology it made some field investigations of cement, bauxite, and asbestos. The coal section, in addition to compiling the annual statistical reports, prepared and issued its regular weekly report on coal and coke, continued to assist the United States Coal Commission up to the date of its termination, maintained contact with the Department of Commerce in its studies of special features of the coal industry, and, in cooperation with the Bureau of the Census, undertook and reported on four canvasses of consumers' stocks of coal. The petroleum and natural gas section, besides performing its routine work in preparing the annual report and monthly statements on petroleum, compiled certain special statistics for the Federal Trade Commission and completed the preparation of a map showing petroleum and natural gas fields and petroleum pipe lines in Texas. The section of foreign mineral reserves was engaged chiefly in completing a world atlas on fuel reserves and in collecting and compiling information on the production of minerals in foreign countries.

In the San Francisco office the demand for statistical work required all the time of the geologist in charge, J. M. Hill, and necessitated the employment of additional temporary clerical help for

about two and one-half months. V. C. Heikes, the statistician in charge of the Salt Lake City office, devoted a large part of his time to special studies of the available supply of arsenic and made several field investigations of arsenic resources and arsenic manufacturing plants. In the Denver office, in addition to making the routine statistical inquiries, C. W. Henderson, in charge, completed an exhaustive paper on the history of mining in Colorado (Prof. Paper 138).

Progress in the compilation of the annual chapters and the preparation of the completed volumes of Mineral Resources of the United States was farther advanced at the end of the year than in recent preceding years. Part I of the volume for 1922 is nearly ready for the printer. All the chapters of Part II were published except those on petroleum, coal, and coke, which were in the hands of the printer at the end of the year. Of the chapters for 1923, 25 were transmitted for publication, and 5 of these were published by the end of the year. The preliminary summary of mineral production in 1923 was transmitted April 8 and was in galley proof at the end of the year. Most of the reports for 1923, like those for several years preceding, have been made brief, primarily to keep within the limit imposed by reduced printing funds and partly because the lack of specialists on certain subjects has made impossible the preparation of more than statistical material for publication.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH

The personnel of the division of chemical and physical research on July 1, 1923, consisted of 7 chemists, 2 physicists, 2 laboratory aids, 1 clerk, 1 laboratory assistant, and 1 laborer. George Steiger was in charge of the division and supervised the work of the chemical laboratory, and C. E. Van Orstrand supervised the work of the physical laboratory. M. A. Shoultes, laboratory aid, resigned on August 31, and C. R. Randall, junior physicist, was appointed to fill the vacancy on March 1.

WORK IN CHEMISTRY

For the official work of the Survey 782 quantitative analyses were made and a number of minerals were determined, the determinations including a careful study of their properties. In addition 2,698 specimens sent to the Survey by persons outside were identified. On June 30 400 samples were awaiting quantitative analysis and 75 specimens awaiting identification.

The bulletin entitled "The data of geochemistry" was revised and prepared for a fifth edition (Bulletin 770) by its author, F. W. Clarke, by adding facts necessary to bring it up to date.

The chemical and physical properties of a group of uranium and vanadium minerals, chiefly from Utah, Colorado, and Peru, were studied by W. T. Schaller. This study has not only shown the composition of these minerals but has furnished data on their age, as well as on the age of the earth. Mr. Schaller also made laboratory experiments to show the relations of minerals of the jarosite group. Recent discoveries of natural silver jarosite (argentojarosite) suggested that gold-platinum-palladium jarosite also exists in nature, and recalculations of analyses of ores from Nevada confirm this suggestion. Mr. Schaller prepared two papers, one for publication in the *American Journal of Science* on the "Occurrence and properties of sincosite" and one for the open files of the Geological Survey on the "Occurrence of phlogopite in the United States."

At the conclusion of a series of laboratory experiments made to elucidate the mode of formation of metallic copper in ore deposits R. C. Wells made a brief report to L. C. Graton and R. S. Butler, geologists cooperating in

the study, and later prepared the manuscript for a bulletin entitled "Deposition of native copper by ascending solutions." Mr. Wells also prepared, for the committee on the measurement of geologic time by atomic disintegration, a bibliography of the literature dealing with the relation of radioactivity to geologic problems, which was published by the National Research Council. A note on the Hicks method of determining potassium was prepared for publication by R. C. Wells, R. K. Bailey, and J. G. Fairchild.

A series of laboratory experiments showing the solubility, the permeability, and the disintegrating effects of nitric acid on granites was concluded, and a paper on the results was prepared by George Steiger. Mr. Steiger also wrote a section on the "Chemical and mechanical analysis of sediments" for a treatise on sediments being prepared for publication by Prof. W. H. Twenhofel of the University of Wisconsin.

The study of the chemical nature of the organic matter in oil shale was continued throughout the year by E. T. Erickson. The object of this study is to discover the source and the mode of formation of petroleum and other natural hydrocarbons, and the information obtained may also be of practical value in the recovery of oil from oil shale. Experiments were made with fish remains taken from a sunken vessel and with a number of samples of sediment from the Bay of Maine. Both investigations afforded data relative to the formation of petroleum from plant and animal material embedded in sediments.

A series of very elaborate assays, necessitating the study and choice of efficient methods for determining extremely small quantities of platinum in rocks reputed to be platinum ores, was made by Mr. Erickson.

E. P. Henderson made 2,698 qualitative determinations of minerals for outside persons. Nearly all the regular routine quantitative analyses were made by J. G. Fairchild.

R. K. Bailey made 662 analyses of potash salts in material from western Texas. A most promising area for deposits of potash is in the southern half of Reagan County, where a potash-rich stratum was indicated at about the 1,300-foot level in each of three wells sunk 800 feet apart. Samples of salts from wells farther east are of the same general character. This is the most encouraging showing of potash yet found.

WORK IN PHYSICS

The section of physics, in addition to cooperating with the geologists in the study of certain special problems, continued investigations in the fields in which it has heretofore worked.

Observations of deep earth temperatures were made in Oklahoma, Pennsylvania, and Wyoming by C. E. Van Orstrand. A paper on "Apparatus for the measurement of temperatures in deep wells by means of maximum thermometers" was published in *Economic Geology*. Another paper summarizing the results of a somewhat extended temperature survey in Yellowstone National Park was published in the *Journal of Geology* under the title "Temperatures in some springs and geysers in Yellowstone National Park."

At the suggestion of G. B. Richardson an attempt was made to develop a method for the empirical representation of petroleum-production curves. A fair degree of accuracy was attained in the representation of the production data for the States of Ohio, Pennsylvania, and West Virginia and for two oil fields—the Kern River field in California and the Batson field in Texas. Manuscript for the fourth edition of *Smithsonian Mathematical Tables, Hyperbolic Functions*, has been submitted to the Smithsonian Institution for publication.

Investigations pertaining to the pore space of oil and gas sands were continued by A. F. Melcher. A paper on "The texture of oil sands with relation to the production of oil" has been submitted for publication in the *Bulletin of the American Association of Petroleum Geologists*. Field and laboratory studies of the texture and productivity of oil sands in the Burbank and Tonkawa fields of Oklahoma were continued. A short field trip to Pittsburgh and Bradford, Pa., was made for the purpose of conferring with geologists and oil companies on the texture of the Bradford oil sand. A. M. Boetcher, a student of George Washington University, and Prof. R. H. Johnson, of the University of Pittsburgh, assisted in the work on pore space. The total number of determinations of pore space made during the year was 150.

C. R. Randall devoted his time to computations and observations in the laboratory.

ALASKAN MINERAL RESOURCES BRANCH

PERSONNEL AND EXPENDITURES

On July 1, 1923, the personnel of the Alaska force consisted of 1 chief Alaskan geologist, 6 geologists, 2 topographers, 1 cadastral engineer, 1 draftsman, and 4 clerks on annual salaries; 1 assistant geologist and 1 junior topographer on monthly salaries; and 2 geologists, 1 assistant geologist, and 1 geologic aid on per diem salaries; and on June 30, 1924, it consisted of 1 chief Alaskan geologist, 7 geologists, 4 topographic engineers, 1 draftsman, and 3 clerks on annual salaries; 1 geologist, 1 junior geologist, and 1 topographic aid on monthly salaries; and 2 associate geologists on per diem salaries.

The funds available for the field season included the current appropriation of \$75,000 for the investigation of Alaskan mineral resources and an unexpended balance of \$14,100 from the similar appropriation available until June 30, 1923. These were allotted as follows:

Allotments for salaries and field and office expenses during field seasons of 1923-24

Professional salaries.....	\$28,887
Field expenses.....	28,100
Clerical salaries and other office expenses.....	6,870
Office of Director.....	10,992
Reserved for field season of 1924.....	14,251
	<hr/>
	89,100

Approximate allotments to different kinds of surveys and investigations during field seasons of 1923-24

Special investigation of geology and mineral resources....	\$10,990
Geologic reconnaissance surveys.....	25,130
Topographic reconnaissance surveys.....	11,600
Map compilation.....	2,200
Collecting mineral statistics.....	1,560
Administration of Alaska branch, including clerical salaries and miscellaneous expenses.....	12,377
Office of Director.....	10,992
Reserved for field season of 1924.....	14,251
	<hr/>
	89,100

Approximate geographic distribution of allotments for investigations in Alaska during field seasons of 1923-24

Special investigation of geology and mineral resources....	\$7,085
Southeastern Alaska.....	5,470
Prince William Sound.....	5,860
Alaska Railroad region.....	2,600
Alaska Peninsula.....	19,280
Yukon basin.....	7,425
Map compilation.....	2,200
Mineral statistics.....	1,560
Administration of Alaska branch, including clerical salaries and miscellaneous office expenses.....	12,377
Office of Director.....	10,992
Reserved for field season of 1924.....	14,251
	<hr/>
	89,100

In addition to the amounts stated a grant of \$75,000 was made by the Department of the Navy, of which \$55,700 was expended in 1923 for a survey of a part of Naval Petroleum Reserve No. 4. The balance, \$19,300, and an additional grant of \$75,000 from the Navy were allotted to the continuation of this work. A grant of \$6,000 from the appropriation for the classification of public lands was devoted to the survey of petroleum lands in Alaska.

Progress of surveys in Alaska, 1898-1923

Year	Appropriation	Areas covered by geologic surveys			Areas covered by topographic surveys *					Investigations of water resources	
		Exploratory (scale 1: 625,000 or 1:1,000,000)	Reconnaissance (scale 1: 250,000)	Detailed (scale 1: 62,500)	Exploratory (scale 1: 625,000 or 1:1,000,000)	Reconnaissance (scale 1: 250,000; 200-foot contours)	Detailed (scale 1: 62,500; 25, 50, or 100 foot contours)	Lines of levels	Bench marks set	Gaging stations maintained part of year	Stream-volume measurements
		Sq. m.	Sq. m.	Sq. m.	Sq. m.	Sq. m.	Sq. m.	Miles			
1898.....	\$46,189	9,500			12,840	2,070					
1899.....	25,000	6,000			8,690						
1900.....	60,000	3,300	6,700		630	11,150					
1901.....	60,000	6,200	5,800		10,200	5,450					
1902.....	60,000	6,950	10,050		8,330	11,970	96				
1903.....	60,000	5,000	5,000	96		15,000					
1904.....	60,000	4,050	3,500		800	6,480	480				
1905.....	80,000	4,000	4,100	536		4,890	787	86	19		
1906.....	80,000	5,900	4,000	421		13,500	40	237	28		
1907.....	80,000	2,600	1,400	442		6,120	501	95	16	14	286
1908.....	80,000	2,000	2,850	604		3,980	427	76	9	48	487
1909.....	80,000	6,100	5,500	450	6,190	5,170	444			55	556
1910.....	90,000		8,635	321		13,815	36			81	708
1911.....	100,000	8,000	10,550	496		14,460	246			66	429
1912.....	90,000		2,000	525			268			66	369
1913.....	100,000	3,500	2,950	180	3,400	2,535	287				381
1914.....	100,000	1,000	7,700	325	600	10,300	10				
1915.....	100,000		10,700	200		10,400	12	3	2	9	
1916.....	100,000		5,100	636		9,700	67			20	
1917.....	100,000		1,750	275		1,050				19	
1918.....	75,000		3,500			1,200					
1919.....	75,000		2,700			2,300				19	
1920.....	75,000		1,480			770				19	
1921.....	75,000		2,130	150		300	206				
1922.....	75,000		4,000			4,300					
1923.....	75,000		8,570			6,530					
Percentage of total area of Alaska.....	2,011,189	73,200	123,665	5,657	51,060	163,430	3,996	462	74		
		12.48	21.09	0.96	8.81	27.87	0.67				

* The Coast and Geodetic Survey, International Boundary Commission, and General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

* In 1921-1923 additional funds were available; see above.

WORK OF THE YEAR

Under the appropriation of \$75,000 and the grant of \$6,000 for the classification of petroleum lands, 7 field parties were dispatched to Alaska in 1923. These parties included 7 geologists, 2 topographic engineers, and 11 auxiliaries. Five of these were engaged in purely geologic work and 2 in combined geologic and topographic

work. Naval Petroleum Reserve No. 4 was surveyed in 1923 by three parties, which were engaged in both classes of work and which included three geologists, three topographic engineers, and 17 auxiliaries. In January, 1924, a large expedition led by Philip S. Smith went to northern Alaska to continue the survey of the petroleum reserve. This expedition reached the head of the Colville in March and was in Arctic Alaska at the end of the fiscal year.

Alfred H. Brooks, chief Alaskan geologist, as official delegate to the Pan-Pacific Science Congress, made a journey to Australia within the fiscal year, returning October 10, 1923. While in the office Mr. Brooks gave about 40 per cent of his time to scientific investigations and the preparation of reports and the remainder to administrative work. Stephen R. Capps gave about 40 per cent of his office time to administrative duties as acting chief Alaskan geologist, and R. H. Sargent gave about the same percentage to the supervision of topographic surveys and to the compilation of maps. Miss Lucy M. Graves devoted the larger part of her time to administering the clerical work of the branch and was in charge of the branch during the absence of the chief and the senior Alaskan geologists. Miss Erma C. Nichols devoted about two-thirds of her time to the collection and coordination of the mineral statistics of Alaska.

A. F. Buddington continued his investigation of the geology and mineral resources of southeastern Alaska and gave special attention to the Hyder district and the nickel deposits in the Sitka district.

F. H. Moffit continued his study of the copper deposits of Prince William Sound.

S. R. Capps during July continued his study of the metal deposits of the region along the Alaska Railroad.

R. H. Sargent, with Kirtley F. Mather, geologist, carried a reconnaissance survey from Kamishak Bay to Katmai.

R. K. Lynt, with Walter R. Smith, geologist, mapped an area lying between Katmai on the north and Cold Bay on the south.

George C. Martin continued from July 18 to August 28 his study of the stratigraphy of Alaska Peninsula and gave special attention to the Cold Bay petroleum field and the Chignik district. His office work consisted chiefly of the completion of a report on the Mesozoic geology of Alaska.

J. B. Mertie, jr., carried a geologic reconnaissance survey from Beaver, on the Yukon, to the Chandalar placer district. Later he studied the geology along the Yukon between Beaver and the Tanana.

Sidney Paige led an expedition to investigate the oil resources of Naval Petroleum Reserve No. 4. The field work began about July 15 and ended about September 9. The northern party, including Sidney Paige, geologist, and E. C. Guerin, cadastral engineer, worked from Wainwright around Point Barrow to Dease Inlet and thence up Meade River about 80 miles. The northeastern party, James Gilluly, geologist, and J. E. Whitaker, topographic assistant, went overland from Peard Bay down to Inaru River and explored Popagarak River for 40 miles. The southern party, W. T. Foran, geologist, and Gerald FitzGerald, junior topographer, landed near Cape Beaufort and surveyed the shore line north to Icy Cape. It mapped Kukpowruk River inland for 35 miles, Kokolik River for 25 miles, and Utukok River for 40 miles and explored the lower part of Wainwright Inlet. The Paige expedition mapped in all 2,150 square miles, but the exploration has thrown much light on the topography and geology of 10,000 square miles in northern Alaska.

C. Arthur Hollick completed his studies of the Alaska Tertiary flora and will soon submit his report.

James McCormick was employed in the Alaskan branch for a part of the year in revising the "Geographic dictionary of Alaska" (Bulletin 209).

The publications of the year consisted of a report on the progress of investigations in Alaska in 1921 (Bulletin 739), a bulletin on the Ruby-Kuskokwim region (Bulletin 754), and three chapters of the report on the progress of investigations in Alaska in 1922 (Bulletins 755-A to 755-C). Brief notices of these publications appear elsewhere in this report.

TOPOGRAPHIC BRANCH

ORGANIZATION

The organization of the topographic branch during the year was as follows:

Chief topographic engineer, C. H. Birdseye.
 Atlantic division, topographic engineer in charge, Frank Sutton.¹
 Central division, topographic engineer in charge, W. H. Herron.
 Rocky Mountain division, topographic engineer in charge, Glenn S. Smith.
 (In the absence of Mr. Birdseye Mr. Smith acted as chief topographic engineer.)
 Pacific division, topographic engineer in charge, T. G. Gerdine.
 Computing section, topographic engineer in charge, E. M. Douglas.
 Section of inspection and editing, topographic engineer in charge, W. M. Beaman.
 Section of cartography, draftsman in charge, A. F. Hassan.
 Map information office, topographic engineer in charge, J. H. Wheat.
 Section of relief maps, geographer in charge, J. H. Renshaw.
 Section of photographic mapping, topographic engineer in charge, T. P. Pen-
 dleton.

PERSONNEL

The technical force was increased by the appointment of 3 junior topographers, 10 topographic aids, and 5 draftsmen and the reinstatement or transfer of 5 topographic engineers, 2 assistant topographic engineers, 1 junior topographer, and 1 assistant map printer. The force was reduced by 11 resignations and 3 transfers. With these changes the corps now includes 1 chief topographic engineer, 4 topographic engineers in charge of divisions, 4 geographers, 77 topographic engineers, 2 topographers, 41 assistant topographic engineers, 30 junior topographers, 10 topographic aids, 1 map editor, 2 map revisers, 1 assistant map printer, and 16 draftsmen, a total of 189. During the year 8 topographic engineers, 6 assistant topographic engineers, and 8 junior topographers were on furlough. In addition, 37 technical field assistants were employed during the whole or a part of the year. The clerical force comprises 15 clerks of various grades, one of whom is a temporary employee, and one messenger.

PUBLICATIONS

The published work of the topographic branch for the fiscal year consisted of 68 new standard topographic maps, 17 river plans and profiles, 2 revised State maps, advance photolithographic prints of 106 new topographic maps now in process of engraving, and 34 photolithographs of new topographic maps for which publication has not yet been otherwise provided. Additional publications were a shaded relief map of Kentucky and shaded relief editions of 5 Pennsylvania and 2 West Virginia standard topographic maps. One State map (completely revised) is in press.

Bulletin 709, giving the results of triangulation and primary traverse in the United States for 1916-1918, in one volume, and Bulletin 689, descriptive of the boundaries, areas, geographic centers, and altitudes of the United States and of the several States, were published during the year.

¹ Mr. Sutton was on annual and sick leave and on leave without pay, owing to illness, from January 1 to June 30.

APPROPRIATIONS

The Federal appropriations for topographic surveys for the fiscal year 1924 were as follows:

Topographic surveys.....	\$500,000.00
Salaries, scientific assistants.....	9,200.09
Special funds for military mapping (contributed by War Department).....	36,048.41
	<hr/> 545,248.41

COOPERATION

Cooperation has been maintained in 19 States and 1 Territory, which contributed the following amounts:

Alabama.....	\$9,976.04	Oregon.....	\$2,374.72
California.....	45,197.06	Pennsylvania.....	9,234.52
Colorado.....	15,472.38	Texas.....	92,363.17
Connecticut.....	2,921.51	Utah.....	7,313.59
Hawaii.....	28,507.96	Vermont.....	2,999.07
Illinois.....	52,962.62	Virginia.....	5,662.58
Iowa.....	2,068.65	Washington.....	5,107.54
Kentucky.....	17,412.29	West Virginia.....	2,997.05
Maine.....	4,983.07	Wisconsin.....	13,391.75
Missouri.....	17,273.05		<hr/>
New York.....	14,979.60		353,198.22

In addition, base-map work was done and paid for by other Federal organizations as follows: For the National Park Service, 1,021.06; for the Coal Commission, \$980.65; for the General Land Office, \$428.99; for the Federal Board for Vocational Education, 96.62. The total amount received from these sources was \$2,527.32.

The total amount expended from all sources for the work of the topographic branch was \$900,973.95.

SUMMARY OF RESULTS

The condition of topographic surveys to June 30, 1924, distinguished as to scale and date, is shown on Plate I.

As shown in the following table, the new area mapped was 16,021 square miles, making the total area surveyed to date in the continental United States, exclusive of Alaska, 1,248,062 square miles, or 1.2 per cent of the entire country. In addition, 644 square miles of resurvey was completed, making the total area of surveys during the year 16,665 square miles. River surveys amounting to 818 linear miles were also made.

In connection with these surveys, 7,781 linear miles of primary levels were run, making 304,975 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 2,059 permanent bench marks were established.

Triangulation stations to the number of 177 were occupied, and 22 were permanently marked.

Primary traverse lines aggregating 5,832 miles were run, in connection with which 1,450 permanent marks were set.

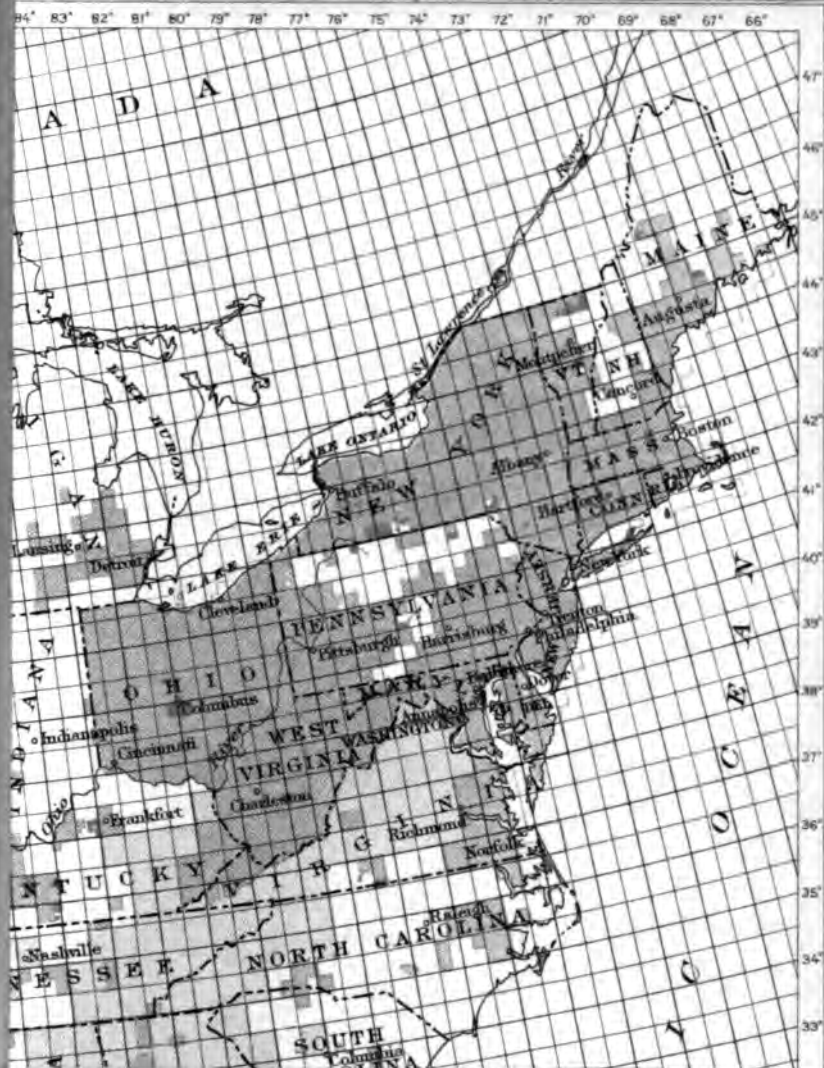
In addition, 696 square miles of topographic mapping was completed in Hawaii and 228 miles of primary levels were run and 90 bench marks established there.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1923, to June 30, 1924

State	New area mapped July 1, 1923, to June 30, 1924	Total area mapped to June 30, 1924	Percent-age of total area of State mapped to June 30, 1924	State	New area mapped July 1, 1923, to June 30, 1924	Total area mapped to June 30, 1924	Percent-age of total area of State mapped to June 30, 1924
	Square miles	Square miles			Square miles	Square miles	
Alabama.....	442	19,634	37.7	New Jersey.....		8,224	100.0
Arizona.....	151	55,580	48.7	New Mexico.....		40,412	32.9
Arkansas.....		21,494	40.3	New York.....	928	48,756	99.0
California.....	840	121,914	77.0	North Carolina.....	40	18,916	36.0
Colorado.....	1,401	52,759	50.7	North Dakota.....		10,017	14.1
Connecticut.....		4,965	100.0	Ohio.....		41,040	100.0
Delaware.....		2,370	100.0	Oklahoma.....		39,908	57.0
Dist. of Columbia.....		70	100.0	Oregon.....	1,160	27,415	28.3
Florida.....		4,716	8.0	Pennsylvania.....	615	31,440	69.6
Georgia.....		24,835	41.9	Rhode Island.....		1,248	100.0
Idaho.....	136	28,722	34.0	South Carolina.....	62	13,737	44.3
Illinois.....	2,544	24,844	43.8	South Dakota.....		19,243	24.8
Indiana.....		3,627	10.0	Tennessee.....	135	21,687	51.6
Iowa.....	38	12,533	22.3	Texas.....	2,180	80,521	28.9
Kansas.....		64,159	78.0	Utah.....	949	17,804	20.9
Kentucky.....	636	20,529	50.5	Vermont.....	543	6,243	65.2
Louisiana.....		8,810	18.2	Virginia.....	156	36,668	86.0
Maine.....	305	11,440	34.7	Washington.....	550	33,269	48.1
Maryland.....		12,327	100.0	West Virginia.....		24,170	100.0
Massachusetts.....		8,266	100.0	Wisconsin.....	802	15,970	38.4
Michigan.....		11,153	19.2	Wyoming.....	14	30,102	30.7
Minnesota.....		7,354	8.7	Total continental United States (exclusive of Alaska).....	16,021	1,248,062	41.2
Mississippi.....		3,881	8.3	Hawaii.....	696	3,671	36.9
Missouri.....	1,394	41,207	59.3				
Montana.....		41,590	28.5				
Nebraska.....		27,117	35.0				
Nevada.....		41,141	37.5				
New Hampshire.....		4,235	45.3				

Topographic surveys from July 1, 1923, to June 30, 1924

State	Contour interval	For publication on scale of—						Total area surveyed		
		1:12,000	1:20,000	1:24,000	1:31,680	1:62,500	1:125,000	New	Resurvey	Total
	Feet	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.
Alabama.....	5, 20			38		404		442		442
Arizona.....	50					151		151		151
California.....	5, 20			325	501			840		840
Colorado.....	50, 100	14				781	620	1,401		1,401
Idaho.....	50, 100					86	50	136		136
Illinois.....	10, 20					2,544		2,544		2,544
Iowa.....	20					38		38		38
Kentucky.....	20			2		634		636		636
Maine.....	20					305		305		305
Massachusetts.....	10		52						52	52
Missouri.....	20					1,394		1,394		1,394
Montana.....	10					10			10	10
New York.....	20					928		928		928
North Carolina.....	20					40		40		40
Ohio.....	10					532			532	532
Oregon.....	{ 5, 10, 20 25, 100 }				40	152	968	1,160		1,160
Pennsylvania.....	20					615		615		615
Rhode Island.....	5, 10		11						11	11
South Carolina.....	10, 20					62		62		62
Tennessee.....	20					135		135		135
Texas.....	5, 10, 20			373		1,807		2,180		2,180
Utah.....	{ 1, 5, 20 50, 100 }			280	530	27	112	949		949
Vermont.....	20					543		543		543
Virginia.....	20					195		156	39	195
Washington.....	25, 100					495	55	550		550
Wisconsin.....	20					802		802		802
Wyoming.....	10			14				14		14
Hawaii.....	10, 50	14	63	1,032	1,071 696	12,680	1,805	16,021 696	644	16,665 696



THE J. L. B. OF BOLD YEAH

Topographic surveys from July 1, 1923, to June 30, 1924—Continued

State	Levels		Primary traverse		Triangulation	
	Distance run	Permanent bench marks	Distance run	Permanent marks	Stations occupied	Stations marked
	<i>Miles</i>		<i>Miles</i>			
	586	123	60	19		
	470	142	539	151	77	54
	169	42			4	4
it	291	79				
	12	1			4	5
	1,035	257	1,258	406		
	59	13	150	33		
	31	19	21	7		
	246	79				
	39	10				
etts	10	3				
	563	159	714	167		
	305	75	208	55		
	76	21	87	18		
nia	138	44	235			
nd	12					
	172	5	228	62		
	2,464	727	1,773	356	40	23
	394	76			14	16
	114	24			28	20
	185	62	235	61		
n	68	16				
nia	31	5				
	281	67	324	83		
	7,781	2,059	5,832	1,450	177	122
	228	90				

GENERAL OFFICE WORK

computations for vertical and horizontal control were made, and ults were copied and cataloged by the computing section. tion of relief maps prepared shaded relief maps of Arizona, n New Jersey, and parts of Pennsylvania and New York, as a special map of parts of Arizona, California, Nevada, and and maps of the Howard, Lock Haven, and Williamsport ngles in Pennsylvania. The map information office was en- in indexing and cataloging the map data available in the Federal departments and a number of non-Federal organi- and in furnishing miscellaneous map information to the

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

section of inspection and editing of topographic maps con- to supervise the office preparation of all topographic maps inspect and edit them before reproduction. It also edited a of maps submitted by other Survey branches and Govern- areaus.

number of topographic maps in progress in the topographic (exclusive of those being engraved and printed) ranged 33 in August to 278 in March; the monthly average was 232. rage of 16 employees were engaged in this section for the

s McCormick spent three-quarters of the year in work for ited States Geographic Board and in other special investiga- id one-quarter of the year in revising the "Geographic dic- of Alaska."

The work of this section is described further under "Publication branch" (p. 77).

SECTION OF PHOTOGRAPHIC MAPPING

The use of aerial photographs for the compilation of planimetric maps as a base for topographic mapping was continued by the section of photographic mapping through cooperation with the Air Service of the United States Army. During the year aerial photographs were adjusted and compiled for use in original field surveys of the Gibson City and Paxton quadrangles (Illinois), the Memphis quadrangle (Tennessee-Arkansas), and the Cotulla 2-b and San Roque Lake 1-a quadrangles (Texas), as well as for a resurvey of the East and West Columbus quadrangles (Ohio). The compilation of the map of Chicago and vicinity and a special map of Camp Grant, Ill., was begun.

SECTION OF CARTOGRAPHY

The map projects include a new wall map of the United States, now in preparation, 40 per cent of the data for which have been prepared for assemblage. The revision of the Wyoming portion of the base of the international map of the world was completed. The compilation, for the Air Service of the United States Army, of air-route maps of an area including more than 100,000 square miles was completed in sections as follows: From Washington, D. C., to Norfolk, Va.; from Washington, D. C., to New York, N. Y.; from New York, N. Y., to Boston, Mass.; from Dayton, Ohio, to Rantoul, Ill.; from Montgomery, Ala., to New Orleans, La.; and from Chicago, Ill., to Iowa City, Iowa. Other air-route maps are in preparation. Maps of proposed dam sites on Colorado River and a map of Arizona showing their locations were drafted. The results of reconnaissance surveys of streams in Colorado and Wyoming were assembled and redrafted, and a series of maps of Missouri River were prepared. Numerous diagrams and graphs were prepared for the Federal Board for Vocational Education and the Bureau of Education. Projections were constructed for field and office use, the road map of Illinois was further revised for the State, and maps of the Texas-Oklahoma boundary line were prepared for printing.

ATLANTIC DIVISION

FIELD WORK

Alabama.—In cooperation with the State geologist of Alabama the survey of the Tuscaloosa quadrangle was completed and that of the Gravelly Springs quadrangle was begun. At the request of the Engineer Corps of the Army the survey of 38 square miles along Tennessee River was completed for a map on the scale of 1:24,000 having a contour interval of 5 feet. For the control of this area 17 miles of primary levels were run and 3 permanent bench marks were established.

Alabama-Tennessee.—At the request of the Engineer Corps of the Army 362 miles of primary levels were run along Tennessee River and 27 permanent bench marks were set, to be used by the Corps in the investigation of the Tennessee River basin.

Connecticut.—In cooperation with the Connecticut State Highway Commission for control of new work 291 miles of primary levels were run and 79 permanent marks were established.

Maine.—In cooperation with the Maine State Water Power Commission the survey of the Attean Pond and Burnham quadrangles was completed and that of the Pierce Pond quadrangle was begun.

Massachusetts.—The resurvey of Camp Devens, Mass., and vicinity was completed, the total area mapped being 52 square miles, for publication on the scale of 1:20,000, with a contour interval of 10 feet. For the control of this area 10 miles of primary levels were run and 3 permanent bench marks established. This work was done for the War Department.

New York.—In cooperation with the New York State engineer the survey of the Arcade, Belmont, Franklinville, and Springville quadrangles was completed and that of the Deposit, Rathbone, Rexville, and Wellsville quadrangles was begun.

Pennsylvania.—In cooperation with the Pennsylvania Department of Forests and Waters, Topographic and Geologic Survey, the survey of the Berlin, Cambridge Springs, Meadville, and Towanda quadrangles was completed and that of the Bradford, Lewistown, and Menno quadrangles was begun.

Pennsylvania-New Jersey.—In cooperation with the Pennsylvania Department of Forests and Waters, Topographic and Geologic Survey, the survey of the Bushkill quadrangle was continued. The area mapped was all in Pennsylvania.

Rhode Island.—The resurvey of Block Island, R. I., an area of 11 square miles, was completed, for publication on the scale of 1:20,000, with contour intervals of 5 and 10 feet. For the control of this area 12 miles of primary levels were run. This work was done for the War Department.

South Carolina.—The survey of the Williston quadrangle, S. C., was completed.

South Carolina-Georgia.—The survey of the Warrenville quadrangle, S. C.-Ga., was completed. The area mapped was all in South Carolina.

Tennessee.—In preparation for the revision of the maps of the Donelson and Nashville Special quadrangles, Tenn., 228 miles of primary traverse were run and 62 permanent marks set.

Tennessee-Missouri-Kentucky.—The survey of the Reelfoot Lake quadrangle, Tenn.-Mo.-Ky., was completed.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Royalton quadrangle was begun. In addition, the survey of the Irasburg, Jay Peak, and Lake Memphremagog quadrangles was completed for the War Department.

Virginia-Maryland.—The resurvey of the Virginia portion of the Indian Head quadrangle was completed, the total area mapped being 21 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Virginia-North Carolina.—In cooperation with the State geologist of Virginia the survey of the Danville quadrangle was completed and that of the Axton and Martinsville quadrangles was begun.

West Virginia.—In cooperation with the State geologist of West Virginia the revision of 16 quadrangles was completed and that of 3 quadrangles was begun.

West Virginia-Virginia.—In cooperation with the State geologist of West Virginia the resurvey of the Peterstown quadrangle was begun.

OFFICE WORK

The drafting of 23 sheets was completed and that of 4 sheets begun. Primary-level circuits were adjusted for 71 quadrangles. Geographic positions were computed for 32 quadrangles.

CENTRAL DIVISION

FIELD WORK

Illinois.—In cooperation with the Department of Registration and Education of Illinois the survey of the Alexis, Carlville, Elgin, Genoa, Harrisburg, Harvard, Havana, Marion, Raymond, Rushville, and Yorkville quadrangles was completed and that of the Beardstown, Griggsville, McHenry, Waverly, and Winchester quadrangles was begun. Additional primary-traverse control has been extended over the Calumet, Chicago, Des Plaines, Evanston, Highland, and Riverside quadrangles in preparation for the resurvey of this area; 477 miles were run and 218 permanent marks set.

Indiana.—In cooperation with the Culver Military Academy 31 miles of primary levels were run, 19 permanent bench marks established, 21 miles of primary traverse run, and 7 permanent marks set, in connection with the survey of Culver, Ind., and vicinity.

Iowa.—In cooperation with the Iowa State Geological Survey the survey of the Albia quadrangle was begun.

Kentucky.—In cooperation with the State Geological Survey of Kentucky the survey of the Spring Lick quadrangle was completed, that of the Cub Run and Waddy quadrangles was continued, and that of the Scottsville quadrangle was begun. A survey was made of the Burnside area, the total area mapped being 2 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet. This work was done in such a manner as to be available for future incorporation into the regular map of the quadrangle of which the area surveyed is a part.

Missouri.—In cooperation with the State geologist of Missouri the survey of the Clarksdale, Gower, Maysville, and Plattsburg quadrangles was completed, that of the Darlington and Meramec Springs quadrangles was continued, and that of the Bolckow, Edge Hill, Kearney, Maitland, Stanberry, and Tarkio quadrangles was begun.

Missouri-Kansas.—In cooperation with the State geologist of Missouri the survey of the Atchison No. 2 quadrangle was completed and that of the Atchison No. 1 quadrangle was begun. The area mapped was all in Missouri.

Ohio.—The resurvey of the East and West Columbus quadrangles, Ohio, was completed and that of the Delaware quadrangle was begun.

Wisconsin.—In cooperation with the State geologist of Wisconsin the survey of the La Farge and Viroqua quadrangles was completed, that of the Black River Falls, North Bend, and Pigeon Falls quadrangles was continued, and that of the Bell Center, Fairchild, Osseo, Shamrock, Stoddard, Strum, and Wauzeka quadrangles was begun.

OFFICE WORK

The drafting of 28 sheets was completed and that of 15 sheets was begun. Primary-level circuits were adjusted for 62 quadrangles. Geographic positions were computed for 87 quadrangles.

ROCKY MOUNTAIN DIVISION

FIELD WORK

Arizona.—In cooperation with the National Park Service the survey of the Supai quadrangle and of the parts of the Grand Canyon No. 1, Grand Canyon No. 2, and Shinumo Altar No. 2 that lie within the Grand Canyon National Park was completed. Special plan and profile surveys of Colorado River from Lees Ferry, Ariz., to Black Canyon, Ariz.-Nev., through Marble and Grand canyons, were made for publication on the scale of 1:31,680, with a contour interval of 50 feet, 253 miles of Colorado River being traversed and mapped and 75 miles of surveys carried up side canyons to appropriate controlling elevations. In connection with this work 22 dam sites were surveyed on the scale of 400 feet to 1 inch, with a contour interval of 10 feet.

Colorado.—In cooperation with the State engineer of Colorado the survey of the Evergreen quadrangle was completed and that of the Pagosa Springs and James Peak No. 3 quadrangles was begun. In addition, the survey of the Elk Head Creek and Pilot Knob quadrangles was completed and that of the Pagoda No. 1 quadrangle was begun.

Idaho.—At the request of the Forest Service the survey of the Casto quadrangle, Idaho, was begun. The survey of the Ozone quadrangle was begun for the geologic branch, and a plan and profile survey of Clearwater River and its tributaries was begun for the land-classification branch, 95 linear miles of river being traversed.

Montana.—In cooperation with the National Park Service the resurvey of the St. Mary Lake area, in Montana, covering 10 square miles, was completed.

Texas.—In cooperation with the Texas State Board of Water Engineers the survey of twenty-six $7\frac{1}{2}$ -minute quadrangles, falling in the following 30-minute quadrangles, was completed: Cleburne, Coleman, Farmersville, Gatesville, Granbury, McKinney, Palo Pinto, San Angelo, Sherwood, Temple, Waco, and Weatherford. The survey of thirty-five $7\frac{1}{2}$ -minute quadrangles, falling in the following 30-minute quadrangles, was begun: Ballinger, Breckenridge, Coleman, Cotulla, Eden, Fort Worth, Gatesville, Georgetown, Granbury, Loma Vista, Palo Pinto, Pearsall, San Roque Lake, Sunset, Taylor, Temple, Waco, and Weatherford. In connection with this work the survey of 10 reservoir sites was completed and that of one was begun, the total area mapped being 978 square miles, for publication on the scale of 1:24,000, with contour inter-

vals of 5 and 10 feet. This work was so performed that its results may be incorporated into the regular maps of the quadrangles of which the areas surveyed form parts.

Utah.—In cooperation with Box Elder, Salt Lake, Tooele, Utah, and Weber counties, Utah, and the United States Bureau of Reclamation the survey of these counties was continued, the total area mapped being 306 square miles. For the control of these projects 149 miles of primary levels were run, 67 permanent bench marks established, 14 triangulation stations occupied, and 16 triangulation stations permanently marked. This work was done to aid in planning irrigation and drainage systems, and the results will be incorporated in regular topographic maps. In addition, the survey of the Accord Lakes, Ferron, and Monument Peak quadrangles was completed and that of the Kyune, Poison Spring, and Soldier Summit quadrangles was begun, the total area mapped being 480 square miles, for publication on the scale of 1:31,680, with a contour interval of 50 feet. A survey of streams in the Uinta Basin, covering 156 linear miles, was made, the total area mapped being 50 square miles, for publication on the scale of 1:31,680, with a contour interval of 20 feet. This work was done for land classification. At the request of the Forest Service the survey of the Fort Douglas quadrangle was begun, the total area mapped being 112 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Wyoming.—At the request of the Bureau of Mines the survey of a special area in the vicinity of Gillette, Wyo., was completed, the total area mapped being 14 square miles, for publication on the scale of 1:24,000, with a contour interval of 10 feet.

OFFICE WORK

The drafting of 18 sheets was completed and that of 16 sheets was begun. Primary-level circuits were adjusted for 51 quadrangles. Geographic positions were computed for 39 quadrangles.

PACIFIC DIVISION

FIELD WORK

California.—In cooperation with the California Department of Public Works the survey of the Burrell, Goshen, Hanford, Laton, Lemoore, Monson, No. 30, Riverdale, and Traver quadrangles was completed and that of quadrangle No. 34 was begun. A part of the Raisin quadrangle was revised. In cooperation with Los Angeles County the survey of the Alhambra, Artesia, Bell, Clearwater, El Monte, Hollywood, Long Beach, Van Nuys, Whittier, and Wilmington quadrangles was completed, the total area mapped being 326 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. Airplane photographs were taken by the Army Air Service, which aided in the progress of the mapping. For the control of this work 138 miles of primary levels were run, 38 permanent bench marks established, and 77 triangulation stations occupied, 54 of which were permanently marked. Practically all the expense of this work was paid by Los Angeles County. In cooperation with the East Bay Municipal Utility District 58 miles of primary levels were run and 26 permanent bench marks established for the control of the Laytonville quadrangle. The survey of the Alleghany mining district was completed, the total area mapped being 14 square miles, for publication on the scale of 1:12,000, with a contour interval of 20 feet. For the control of this area 41 miles of primary levels were run and 14 permanent bench marks established. This work was done for the geologic branch.

California-Oregon.—A plan and profile survey was made of Klamath River from Keno, Oreg., to the mouth of Scott River, Calif., a distance of 104 miles. This work was done for the land-classification branch and in cooperation with the California-Oregon Power Co.

Hawaii.—In cooperation with the Territory of Hawaii the survey of the following quadrangles was completed: Honakahau SE. $\frac{1}{4}$, Honakahau SW. $\frac{1}{4}$, Keahole NE. $\frac{1}{4}$, Koolau NW. $\frac{1}{4}$, Lanai NE. $\frac{1}{4}$, Lanai NW. $\frac{1}{4}$, Lanai SW. $\frac{1}{4}$, Lanai SE. $\frac{1}{4}$, Makelawena SE. $\frac{1}{4}$, Makana NE. $\frac{1}{4}$, Makana NW. $\frac{1}{4}$, Makana SW. $\frac{1}{4}$, Makana SE. $\frac{1}{4}$, Puako NE. $\frac{1}{4}$, Puako NW. $\frac{1}{4}$, Puako SW. $\frac{1}{4}$, and Puako SE. $\frac{1}{4}$. The survey of the following quadrangles was begun: Haleakala NW. $\frac{1}{4}$, Kailua NE. $\frac{1}{4}$, Kailua N. W. $\frac{1}{4}$, Kailua SW. $\frac{1}{4}$, and Koolau SW. $\frac{1}{4}$.

Oregon.—In cooperation with the State engineer of Oregon the survey of the Stayton quadrangle was completed. The survey of the Waldo Lake quadrangle was completed and that of the Mount Hood quadrangle was begun.

This work was done for the Forest Service. The survey of the Twickenham quadrangle was continued for the geologic branch. A plan and profile survey of Rogue River, covering 113 linear miles of the river, was continued, the total area mapped being 40 square miles, for publication on the scale of 1:31,680, with contour intervals of 5 and 10 feet; and a plan and profile survey of Illinois River, covering 66 linear miles of the river, was begun. This work was done for the land-classification branch and in cooperation with the California-Oregon Power Co. In addition, a plan and profile survey of Umpqua River, covering 31 linear miles of river, was begun for the land-classification branch. In connection with these surveys several dam sites were surveyed.

Washington.—In cooperation with the Washington State Department of Conservation and Development the survey of the Washtucna, Wheeler, and Schrag quadrangles was completed and that of the Chewelah quadrangle was begun. In addition the survey of the Mount Rainier quadrangle was begun, the total area mapped being 20 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This work was done for the Forest Service.

OFFICE WORK

The drafting of 36 sheets was completed and that of 7 sheets was begun. Primary-level circuits were adjusted for 20 quadrangles. Geographic positions were computed for 49 quadrangles.

WATER-RESOURCES BRANCH

ORGANIZATION

The work of the water-resources branch was conducted under the supervision of N. C. Grover, chief hydraulic engineer, and is organized in five divisions:

- Division of surface water, John C. Hoyt, hydraulic engineer, in charge.
- Division of ground water, O. E. Meinzer, geologist, in charge.
- Division of quality of water, W. D. Collins, chemist, in charge.
- Division of power resources, A. H. Horton, hydraulic engineer, in charge.
- Division of land-classification investigations, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL

During the year the technical force was reduced 11 and was increased 29, a net increase of 18. At the end of the year the force consisted of 1 chief hydraulic engineer, 33 hydraulic engineers, 12 engineers, 25 assistant engineers, 35 junior engineers, 4 geologists, 3 assistant geologists, 1 chemist, 3 associate chemists, and 8 classifiers, a total of 125. Of this number 4 hydraulic engineers, 2 engineers, 2 assistant engineers, 5 junior engineers, and 1 assistant geologist were employed occasionally. In addition the advisory board of the superpower investigation was dissolved and the appointments of the 13 members who gave occasional service in the study of superpower problems were canceled.

In the clerical force there were 9 separations and 9 accessions, and at the end of the year the force numbered 33. Of this number 6 have been employed only at times. One skilled laborer also was employed occasionally.

ALLOTMENTS

The appropriation for gaging streams was \$170,000. In addition \$71,427.16 of the appropriation for the classification of lands was expended for field work by the water-resources branch. Of the total appropriations 66 per cent was allotted to work in public-land States. The cooperative funds made available by State allotments have been increased in some States and decreased in others, and the changes have necessitated corresponding adjustments of this work. The total

mount of these funds available for work to be done during the year as \$282,002.47.

Allotments of funds for gaging streams, 1923-24

Administration, general.....	\$18,711.52	Surface water—Continued.	
Ranch administration.....	9,500.00	Montana.....	\$5,000.00
Inspection.....	1,000.00	North Dakota.....	300.00
Computations.....	13,000.00	Utah.....	5,000.00
	<u>40,211.52</u>	Nevada.....	2,500.00
Surface water:		Idaho (Boise).....	3,900.00
Connecticut.....	500.00	Idaho (Idaho Falls).....	1,100.00
Maine.....	1,000.00	Oregon.....	5,000.00
New Hampshire.....	1,500.00	Washington.....	5,000.00
Vermont.....	1,000.00	California.....	5,500.00
Massachusetts.....	2,500.00	Arizona.....	3,500.00
New York.....	5,500.00	Hawaii.....	
New Jersey.....	3,000.00	Field.....	\$3,500
Middle Atlantic States.....	4,000.00	Washington.....	1,000
North Carolina.....	4,000.00		<u>4,500.00</u>
Tennessee-Kentucky.....	3,000.00		<u>97,100.00</u>
Ohio.....	3,000.00	Ground water.....	11,500.00
Texas.....	5,000.00	Quality of water.....	13,500.00
Wisconsin.....	3,500.00	Power resources.....	7,000.00
Minnesota.....	300.00	General supplies.....	500.00
Iowa.....	2,000.00	Contingent.....	188.48
Illinois.....	1,500.00		<u>170,000.00</u>
Missouri.....	4,000.00		
Kansas.....	3,500.00		
Colorado, Wyoming,			
New Mexico.....	7,000.00		

COOPERATION

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Alabama.....		\$60.00
Arizona:		
Stream gaging.....	\$11,799.99	
Colorado River.....	7,000.00	
Ground water, San Pedro Valley.....	850.00	
		<u>19,649.99</u>
California:		
State.....	22,582.50	
County and city.....	8,464.62	
		<u>31,047.21</u>
Colorado:		
State.....	1,500.00	
Municipal.....	200.00	
		<u>1,700.00</u>
Florida.....		1,800.00
Hawaii.....		18,439.76
Idaho:		
State Department of Reclamation—		
Outside of Snake River basin.....	12,194.87	
SNAKE RIVER BASIN.....	2,175.06	
Bureau of Mines and Geology.....	922.88	
		<u>15,292.81</u>
Illinois:		
State.....	3,755.38	
Municipal.....	60.00	
		<u>3,815.38</u>

Iowa:		
State Highway Commission.....	\$2, 459. 04	
State Geological Survey.....	749. 92	
		\$3, 208. 96
Kansas.....		4, 913. 11
Kentucky.....		330. 00
Maine.....		5, 107. 11
Massachusetts.....		3, 059. 86
Minnesota.....		483. 49
Missouri.....		8, 774. 51
Montana.....		6, 442. 50
Nevada.....		1, 449. 37
New Hampshire.....		1, 807. 79
New Jersey:		
Stream gaging.....	9, 354. 28	
Ground water.....	5, 084. 24	
		14, 438. 52
New York:		
State.....	10, 492. 00	
County and city.....	592. 84	
		11, 084. 84
North Carolina.....		5, 919. 67
North Dakota:		
Stream gaging.....	817. 00	
Ground water.....	800. 00	
		1, 617. 00
Ohio.....		24, 866. 43
Oregon:		
State.....	6, 428. 24	
Municipal.....	1, 750. 83	
		8, 179. 07
Tennessee.....		4, 683. 55
Texas:		
State Board of Water Engineers.....	62, 700. 00	
Municipal.....	292. 41	
		62, 992. 41
Utah.....		3, 102. 68
Washington:		
State.....	4, 157. 89	
Municipal.....	695. 36	
		4, 853. 25
West Virginia:		
State.....	495. 22	
Municipal.....	20. 30	
		524. 52
Wisconsin.....		6, 252. 34
Wyoming.....		6, 106. 34
		282, 002. 47

The work done under cooperative agreements with the States has been restricted to studies of stream flow, except in Arizona, Connecticut, Idaho, New Jersey, and North Dakota, where ground-water investigations also have been made. (See p. 63.)

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects under construction was continued in cooperation with the United States Bureau of Reclamation. The field work was done by Survey engineers who were employed where the measurements were made, and the cost was met by the Bureau of Reclamation through transfer of funds. Geologic investigations of reservoir sites or ground-water supplies were made for the Bureau of Reclamation in Idaho, New Mexico, Oregon, and Washington. (See pp. 62–64.)

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued on the Crow, Fort Hall, Yakima, Colville, Klamath, Wind River Diminished, Western Shoshone, Walker River, and Uinta Indian reservations.

National Park Service.—Streams in the Yosemite and Yellowstone national parks were measured during the year at stations maintained in cooperation with the National Park Service.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service. Stream gaging in the Arapaho and Uncompahgre national forests was done by the Forest Service, the cost of which was reimbursed by the Geological Survey.

City of San Francisco.—In connection with the storage of the water of Tuolumne River in Hetch Hetchy Valley as a water supply for the city of San Francisco, measurement of that stream was continued in cooperation with the city government.

Federal Power Commission.—Projects of the Federal Power Commission in Arizona, New Mexico, and Idaho were examined, and the examination of one in Oregon is in progress. The operation of six licensees of the commission in California, four in Oregon, three in Idaho, two in Washington, one in Idaho-Oregon, and one in Nevada were supervised by the Geological Survey, as well as the operations of six permittees of the commission in Oregon, three in Arizona, four in Idaho, two in California, one in Utah, one in Utah-Wyoming, one in New Mexico, and one in Montana. All stream gaging by permittees of the commission is done in cooperation with the Geological Survey. Such cooperative stream gaging is in progress in Alabama, Arizona, Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Kentucky, Louisiana, Michigan, Minnesota, Missouri, Montana, Nevada, New Mexico, North Carolina, Oregon, Pennsylvania, South Carolina, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

Office of the Chief of Engineers.—Stream gaging has been done in the basins of Tennessee and Cumberland rivers in cooperation with the office of the Chief of Engineers.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 17 reports and 2 separate chapters. Titles and brief summaries of these publications are given elsewhere in this report. At the end of the year 27 other reports were in press and 8 manuscripts were awaiting editorial work.

DIVISION OF SURFACE WATER

ORGANIZATION

The work of the division of surface water consists primarily of the measurement of the flow of rivers, but it includes also special investigations of conditions affecting stream flow and the utilization of

the streams. In carrying on the work the United States is divided into 23 districts, including Hawaii. The district offices and engineers in charge are as follows:

New England: C. H. Pierce, Customhouse, Boston, Mass.
 New York: A. W. Harrington, Journal Building, Albany, N. Y.
 New Jersey: O. W. Hartwell, Statehouse, Trenton, N. J.
 Middle Atlantic and Ohio River: A. H. Horton, Washington, D. C.
 South Atlantic and eastern Gulf: W. E. Hall, 6 Government Street, Asheville, N. C.
 Tennessee: W. R. King, Municipal Building, Chattanooga, Tenn.
 Ohio: Lasley Lee, Brown Hall, Ohio State University, Columbus, Ohio.
 Upper Mississippi River: S. B. Soule, Capitol Building, Madison, Wis.
 Illinois: H. E. Grosbach, Kimball Building, Chicago, Ill.
 Iowa: J. B. Spiegel, State Highway Commission Building, Ames, Iowa.
 Kansas: H. R. Kinnison, Federal Building, Topeka, Kans.
 Missouri: H. C. Beckman, Rolla, Mo.
 Upper Missouri River: W. A. Lamb, Montana National Bank Building Helena, Mont.
 Rocky Mountain: Robert Follansbee, Post Office Building, Denver, Colo.
 Great Basin: A. P. Purton, Federal Building, Salt Lake City, Utah.
 Idaho: C. G. Paulsen, Idaho Building, Boise, Idaho.
 Snake River Basin: G. C. Baldwin, Federal Building, Idaho Falls, Idaho.
 Washington: G. L. Parker, Federal Building, Tacoma, Wash.
 Oregon: F. F. Henshaw, Post Office Building, Portland, Oreg.
 California: H. D. McGlashan, Customhouse, San Francisco, Calif.: sub-office, Federal Building, Los Angeles, Calif.
 Arizona: W. E. Dickinson, care of University of Arizona, Tucson, Ariz.
 Texas: C. E. Ellsworth, Capitol Building, Austin, Tex.
 Hawaii: E. D. Burchard, Capitol Building, Honolulu, Hawaii.

CHARACTER AND METHOD OF WORK

Field investigations necessary to the work are made from the district offices, where the results are examined and corrected, if correction is necessary, to insure their accuracy and completeness. At selected gaging stations the volume of water carried by the streams is measured and records of stage and other data are collected from which the daily flow of the streams is computed. The data thus collected are transmitted from the district offices to Washington, where they are reviewed in the computing section and prepared for publication. By this review the records obtained in different parts of the country are brought to a uniform standard, and standardization is further effected through annual conferences of the engineers.

At the end of the year 1913 gaging stations were being maintained, including 73 in Hawaii; 317 stations were discontinued, and 399 new stations established during the year. Records for about 162 additional stations were received, ready for publication, from Government bureaus and private persons, and a number of Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

g stations and cooperating parties for the year ended June 30, 1924

Territory	Geological Survey alone	Bureau of Reclamation	Forest Service	Indian Office	Army engineers	Weather Bureau	Other Federal bureaus	State cooperation	Municipal cooperation	Private persons	Counted more than once	Maintained at end of year	Established during year	Discontinued during year	Regular gaging during year	Miscellaneous gaging during year
		2		1	2	1	3	1	1	6	2	9			33	4
						3			4	1	14	29	7		683	59
										2		2			10	4
	4	2	21	1		1	5	216	46	101	173	218	25	1	1,706	431
ut	1							23	1	6	3	37	4	3	131	
										2		3			14	
										1		2			2	
										2		2		11	13	2
		7	5	15		2		108	3	198	94	244	152	142	1,972	310
					2	2		29	1	1	6	29			60	
						6		24		6	8	28			98	2
						4		32	1	10	15	32	6	5	202	
					6	1		6			7	6			39	
										3		3			39	1
	3							16		6	6	16	1	1	100	
setts								18		1	1	4	1		23	8
										1	1	18	1		127	2
										1		1	1	1	1	
					2	2		6		1		11	1		28	1
						1		55		12	13	55	7	3	332	17
	6	31		2			15	47		6	14	103	5	24	405	12
				3				25		10	13	25	1	5	93	1
upshire								15		12	12	15	2		102	2
y-						1		37	5	8	14	37	4		204	80
ico		1								1		1			6	
rolina					1			58	1	23	25	58	8	5	333	
kota					15			16	1	6	7	31	19	18	201	4
								8				8			29	
					4	4		41	10	9	2	66	27	7	401	28
										5		5	5		2	
		2	1	5		7		82	20	38	76	88	30	31	514	56
olina.										1		1			5	
					38	15		43		7	60	43			282	20
					1	13		123	9	18	41	123	74		1,078	143
	1						1	49		21	28	49	1		117	13
	2			5						6		7	1	7	22	5
					7	1				4		14			48	
on.	3		4	8			2	46	21	25	46	63	10	12	355	22
inia.					6			11		9	6	20	1		31	
					3			40		8	11	40	1	1	159	11
		8	1	5		1	6	37		8	11	55	4	9	207	1
								73	2	13	15	73		2	434	80
	20	54	38	53	87	65	32	1,314	135	508	723	1,673	399	317	10,641	1,319

PUBLICATIONS

convenience and uniformity in publications, the United States is divided into 12 primary drainage basins, and the results of measurements are published annually in a series of progress reports that correspond to these 12 divisions; the records for the 12 divisions are published in three papers. In addition to the progress reports, special reports on hydraulic subjects have been compiled for publication during the year.

DIVISION OF GROUND WATER

GENERAL FEATURES

The division of ground water investigates the waters that lie below the surface—their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and at watering places for stock and desert travelers. Each year surveys are made of

selected areas where problems of water supply are urgent, and the results are generally published in reports that include maps showing the ground-water conditions. The investigations relating to quality of water are made in cooperation with the division of quality of water; the surveys in the Atlantic Coastal Plain are made largely by the geologic branch. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects.

A laboratory, in charge of N. E. Dowell, has been established for determining the hydrologic properties of water-bearing materials. Of 97 samples of water-bearing materials that were collected in New Jersey, Montana, Idaho, and Oklahoma for tests of mechanical composition, porosity, moisture equivalent, and permeability, the work on 41 has been completed and that on 56 has been partly completed. A new apparatus has been developed for determining permeability under low hydraulic gradients, and experiments have been made which indicate that with this apparatus reliable results can be obtained with heads of only a few feet to the mile.

During the year two papers by O. E. Meinzer relating to the general subject of ground-water hydrology were published—Water-Supply Paper 489, "Occurrence of ground water in the United States, with a discussion of principles," and Water-Supply Paper 494, "Outline of ground-water hydrology, with definitions." A paper was prepared by Mr. Meinzer on large springs in the United States, and progress was made by him on his paper on the origin, discharge, and quantity of ground water in the United States. A paper by Mr. Meinzer on the origin of the thermal springs of Nevada, Utah, and southern Idaho, and a paper by Kirk Bryan on the temperature of the spring waters at Hot Springs, Ark., are to be published in the *Journal of Geology*. Two brief papers on the quality of certain ground waters in Montana in relation to the geologic conditions were prepared by B. Coleman Renick, one of which is to be published in the *Journal of Geology* and the other as a contribution to hydrology.

In February, 1924, Mr. Meinzer delivered a course of lectures on ground water at the annual meeting of the Minnesota Well Drillers Association in St. Paul. These lectures are being published in the *Howell Drillers News*.

Cooperation with the committee on physiography was continued through Mr. Meinzer, who serves on that committee. Several manuscripts for geologic folios were examined with respect to their treatment of ground water.

WORK BY STATES

Arizona.—Progress was made on a report on the geology and water resources of San Pedro Valley, Ariz., by Kirk Bryan, of the Geological Survey, and G. E. P. Smith, of the Arizona Agricultural Experiment Station.

Arkansas.—Studies of the temperature and source of the hot-water supply in the Hot Springs National Park, Ark., were continued by Mr. Bryan.

California.—A comprehensive report entitled "The Mohave Desert region—a geographic, geologic, and hydrologic reconnaissance," was completed by D. G. Thompson for publication as a water-supply paper. This paper was made available to the public in manuscript form, copies of it being filed in the Washington and Los Angeles offices of the Geological Survey. Water

evels were measured in selected wells in southern California, as in previous years, under the direction of F. C. Ebert. At the request of the Director of the Veterans' Bureau an examination was made relating to a water supply for a proposed hospital near Livermore, Calif. Charles H. Lee made this examination.

Connecticut.—A paper on ground water in the Pomperaug drainage basin, Conn., with special reference to intake and discharge, by O. E. Meinzer and C. E. Dowell, was completed and is to be published as a water-supply paper. The work was done in cooperation with the State Geological and Natural History Survey.

Hawaii.—Field work was begun by H. T. Stearns in the Kau district, island of Hawaii, to complete an investigation of the geologic and ground-water conditions left unfinished by the resignation of W. O. Clark.

Idaho.—Observations were continued in the Mud Lake basin, Idaho, through cooperation with C. G. Paulsen, district engineer of the surface-water division in Idaho. A brief report on the basin, including the records obtained during the first two years of the investigation, was prepared by H. T. Stearns and L. L. Bryan. Progress was also made on the final report on the Mud Lake basin. A report by A. M. Piper on the Goose Creek basin was published as Bulletin 6 of the Idaho Bureau of Mines and Geology, and a report by O. E. Meinzer on the Pahsimeroi Valley was published as Pamphlet 9 of that bureau. During the year Mr. Piper completed his report on the geology and water resources of the Bruneau River basin and begun field work on the artesian-water conditions in Camas Prairie. Mr. Stearns examined the region of recent lavas west of Arco and prepared a report for the National Park Service recommending the withdrawal of an area in this region as a national monument. The area has since been established as the Craters of the Moon National Monument. The ground-water work in Idaho is done in cooperation with the State Bureau of Mines and Geology. The work in the Mud Lake basin received financial support from the United States General Land Office and the Idaho Bureau of Reclamation. At the request of the United States Bureau of Reclamation investigations were made by Mr. Stearns of the Island Park reservoir site of the Dubois project and of two reservoir sites of the Empire irrigation district. Reports on both projects were transmitted to the Commissioner of the Bureau of Reclamation.

Montana.—George M. Hall completed his report on Yellowstone and Treasure counties, Mont., and made progress on his report on Big Horn County. He also completed field work in Fergus County. B. Coleman Renick made a ground-water survey of the central and southern parts of Rosebud County and nearly completed a report thereon. An examination of ground-water conditions in the vicinity of Ingomar was made by Mr. Renick, and a manuscript report based on this work was sent to the citizens of Ingomar.

New Jersey.—An investigation of the quantities of ground water available for public and industrial supplies in New Jersey has been in progress during the year in cooperation with the State Department of Conservation and Development. The work has been in charge of D. G. Thompson, who has been assisted at times by F. Clark Rule and H. C. Barksdale. Special attention was given to the water supplies at Atlantic City and Camden, and experiment stations were established at the pumping plants of Atlantic City and Perth Amboy.

New Mexico.—At the request of the Bureau of Reclamation a brief field study of the ground-water supplies available for irrigation in Estancia Valley, N. Mex., was made by O. E. Meinzer and Charles H. Lee, and a report, prepared by Mr. Lee, was transmitted to the Bureau of Reclamation.

North Dakota.—The decline of the artesian water supply in the Edgeley quadrangle, N. Dak., has been under observation for nearly ten years, chiefly by H. A. Hard. In the fall of 1923, through the cooperation of the North Dakota Geological Survey, the quadrangle was covered by C. E. Turnbaugh, an experienced artesian-well driller, who measured the discharge of all the artesian wells. A paper based on records obtained for several years was prepared by O. E. Meinzer and H. A. Hard on the artesian water supplies of the Dakota sandstone in North Dakota, with special reference to the Edgeley quadrangle. It will be published as Water-Supply Paper 520-E. Progress was

made by Howard E. Simpson, water geologist of the State Geological Survey, on a comprehensive report on the ground-water resources of North Dakota.

Oklahoma.—At the request of the city of Enid, Okla., Mr. Renick made an examination to discover additional ground-water supplies for that city and prepared a report giving the results of his work. This report was transmitted to the mayor of the city and was afterward published by the Survey as Water-Supply Paper 520-B.

Oregon.—At the request of the Bureau of Reclamation Kirk Bryan examined the reservoir site of the Owyhee Irrigation project, Oreg., and prepared a report on the subject, which was transmitted to the Commissioner of the Bureau of Reclamation.

South Carolina.—Progress was made on a report on ground water in the Coastal Plain of South Carolina by C. W. Cooke, of the geologic branch.

Texas.—A report on ground water in the Coastal Plain of Texas southwest of Brazos River, by Alexander Deussen, was completed and is to be published as a water-supply paper.

Virginia.—At the request of the city of Purcellville, Va., an examination of the ground-water conditions in that vicinity was made by Mr. Hall, and a report based on this examination was transmitted to the city officials.

Washington.—Kirk Bryan, who in April, 1923, had been assigned as geologist to an investigation of the Columbia Basin project, Wash., by the United States Bureau of Reclamation, completed his field work and prepared a report, which was transmitted to the Commissioner of the Bureau of Reclamation. He also made a preliminary investigation and report on the reservoir site for the Cle Elum project. At the request of the Department of Justice an examination was made by Mr. Bryan as to an additional water supply for the Federal Prison on McNeil Island, and a report thereon was transmitted to the Superintendent of Prisons.

DIVISION OF QUALITY OF WATER

During the year 819 samples of water were analyzed, and studies were made of several methods of water analysis. Analyses were made for ground-water reports on Rosebud County, Mont. (123 analyses), Fergus County, Mont. (60), Pomperaug Valley, Conn. (11), and Enid, Okla. (5). Analytical work was practically completed for reports on quality of water in Florida (330 analyses) and on Pecos River, Tex. (91); work was started on reports on quality water in New Jersey (103) and in Rhode Island (30). Manuscripts of three ground-water reports and proof of two reports were reviewed and checked with reference to statements in regard to quality of water and tabulation of analyses. A brief report on the temperature of waters was practically completed. The text of a report on the production of mineral water in 1922 was prepared for the division of mineral resources, and a paper on the determination of manganese in water was prepared for publication in Industrial and Engineering Chemistry.

DIVISION OF POWER RESOURCES

The work of the division of power resources during the year comprised the preparation of monthly reports of the production of electricity and consumption of fuel by public-utility power plants, of reports on the stock of coal on hand at such plants at different dates, and of a report on the developed water power of the United States.

The monthly reports are based on reports submitted by public-utility companies. About 4,000 power plants, each having a monthly output of 10,000 kilowatt-hours or more, are requested to submit reports of their production of electricity and consumption of fuel.

The total capacity of the generators in these plants in January, 1924, was about 17,800,000 kilowatts. Reports received represent over 95 per cent of the total generating capacity of these plants. Each report is published about 30 days after the end of the last month included in it. The following tables show the power and fuel statistics for the calendar years 1919 to 1923:

Electricity produced at public-utility power plants in the United States, 1919-1923

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)
1919	38,921,000,000		14,606,000,000	37.5		24,315,000,000	62.5	
1920	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921	40,976,000,000	-5.9	14,971,000,000	36.5	-7.3	26,006,000,000	63.5	-5.1
1922	47,659,000,000	+16.3	17,206,000,000	36.1	+14.9	30,453,000,000	63.9	+17.1
1923	55,674,000,000	+16.8	19,348,000,000	34.8	+12.4	36,327,000,000	65.2	+19.3

Fuel consumed in the production of power at public-utility plants in the United States, 1919-1923

Year	Coal		Fuel oil		Gas	
	Short tons	Change from previous year (per cent)	Barrels	Change from previous year (per cent)	M cubic feet	Change from previous year (per cent)
1919	35,100,000		11,050,000		21,408,000	
1920	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.0
1922	34,179,000	+8.3	13,197,000	+9.6	27,172,000	+14.5
1923	38,954,000	+14.0	14,679,000	+11.2	31,433,000	+15.7

Reports on the stock of coal held by electric public-utility power plants were made for inclusion in reports on commercial stocks of coal undertaken by the Bureau of the Census, Department of Commerce, and the Geological Survey under authority of the Federal Fuel Distributor. Four of these reports were prepared during the year, giving the stock of coal held on the first day of the months of July, August, and September, 1923, and January, 1924.

DIVISION OF LAND-CLASSIFICATION INVESTIGATIONS

The division of land-classification investigations performed certain technical work required for the classification of the public lands with respect to their water resources. The work is done mainly by the use of funds allotted by the land-classification branch and by men from both branches who are sent to the field in summer and spend the winter in the office in preparing reports. The work comprises the examination of public lands for designation under the enlarged

and stock-raising homestead laws and the examination of streams and neighboring lands for the classification of public lands with respect to their value for water power or irrigation.

ENLARGED AND STOCK-RAISING HOMESTEADS

The work of examining lands for classification under the enlarged and stock-raising homestead laws was continued during the year, but more time was given to general reconnaissance examinations, especially in Kansas, Nebraska, southeastern Montana, New Mexico, western North Dakota, Oklahoma, South Dakota, northeastern Wyoming, and eastern Idaho. During the summer of 1923 examination was made of all lands included in applications pending at the beginning of the year in Arizona, California, Colorado, Idaho, Kansas, Nebraska, North Dakota, Oklahoma, Oregon, South Dakota, Utah, and Washington and of most of the lands included in such applications in Montana, New Mexico, and Wyoming—a total of about 2,000 applications.

Examination was also made to determine the value as public water reserves of tracts of land in Arizona, the Mohave Desert region in California, and Wyoming.

During the field season of 1924 work was begun early in June and at the end of the month had been completed in Arizona and New Mexico and was in progress in Colorado, Idaho, Montana, Oregon, South Dakota, Utah, and Wyoming.

POWER AND IRRIGATION

Arizona.—Hydraulic engineers were attached to the topographic survey party that traversed and mapped Colorado River from Lees Ferry, Ariz., to the lower end of Black Canyon. Surveys of all promising dam sites in that stretch were made under their supervision, and a report on the potential water power and storage capacities of the various dam sites and of the river below the mouth of the Green is in preparation. At the request of the Federal Power Commission examination of a project to develop power on Salt River was made and a report giving its results was prepared, and a report was made on a proposed power development on Black River.

Colorado.—A reconnaissance survey has been made on streams tributary to South Platte River north and west of Denver to determine the power value of lands set aside as power-site reserves. A similar survey is in progress in the Colorado River basin, a survey of Blue River from Dillon to its mouth having been completed and a survey of Eagle River from Redcliff to its mouth being under way. An examination and a report were made for the Federal Power Commission with respect to the power value of lands along Clear Creek in T. 3 S., R. 74 W. sixth principal meridian. Work has been started on a report on the utilization of Colorado River in Colorado and Utah to the mouth of Green River.

Idaho.—In order to determine the location and extent of special surveys for dam and reservoir sites along Clearwater River, Idaho, and to obtain information for incorporation in a report on the power value of that river and the adjacent lands, an engineer is working with a topographic party that is making surveys along the river. At the request of the Federal Power Commission an examination and report were made on a project to develop power on Crane Creek. Supplemental statistics were compiled from records of the State Department of Reclamation to show the amount and location of irrigated land in Snake River basin. A summary report has been prepared on the power resources of Snake River between Huntington, Oreg., and Lewiston, Idaho, to be published as Water-Supply Paper 520-C.

Montana.—An investigation of the use of water for power and irrigation and of the possible future use of water, principally for irrigation, in the drainage area of Missouri River above the mouth of Portage Creek (12 miles below Great Falls, Mont.), begun in June, 1923, was completed at the end of August. An examination was made to determine the irrigability of the bottom lands along Missouri River from Fort Benton, Mont., to the Montana-North Dakota State line.

New Mexico.—At the request of the Federal Power Commission an examination and a report were made on a project to develop power on Gila River in Grant County, N. Mex.

Oregon.—In order to designate possible dam sites for detailed survey and to obtain information for reports on the power value of the streams and adjacent lands an engineer was detailed to a party making a survey of Klamath River from Keno, Oreg., to a point about 100 miles downstream, and two engineers are now detailed to parties surveying Umpqua River and its tributaries. Similar work that was being done in the Rogue River basin at the beginning of the year has been completed. An examination and a report were made for the Federal Power Commission with regard to the water-power resources of Trask, Nestucca, and Smith rivers. An examination is being made for the Federal Power Commission of a project to develop power on Crooked River. An office study, which was in progress during the previous year, of the water supply of streams in Oregon that flow to the Pacific Ocean between Klamath and Columbia rivers was completed.

Utah.—An investigation was made in the Escalante Desert, Utah, to determine the location of lands susceptible of irrigation from wells in a strip extending from a point 20 miles north of Milford, on the Los Angeles & Salt Lake Railroad, southwestward, approximately parallel to the railroad, to the Utah-Nevada State line. Early in the year an engineer began to supervise a topographic survey of streams in the Uinta Basin and to make an examination of the region in order to report on the power value of the lands along the streams. This work is still in progress. Reports have been made for office use on the power value of lands in the Weber River basin included in power-ite reserves, and some work has been done on similar reports for the San Rafael and Sevier River basins. Work has been continued on a report, to be published as a water-supply paper, on the utilization of Green River, in Wyoming, Colorado, and Utah.

Wyoming.—A reconnaissance survey of Sweetwater River, Wyo., begun in June, 1923, to determine the power value of the stream and adjacent lands between T. 28 N., R. 101 W., and T. 29 N., R. 85 W., a distance of more than 60 miles, was completed in July. A similar survey, covering a stretch of about 40 miles, was made of Encampment River and adjacent lands. At the request of the Federal Power Commission a brief investigation was made of the power value of lands lying along Torrey Lake outlet, a tributary of Wind River. (For report on Green River see Utah.) •

LAND-CLASSIFICATION BRANCH

ORGANIZATION AND PERSONNEL

At the end of the fiscal year the organization and technical personnel of the land-classification branch were as follows:

Chief, Herman Stabler.

Assistant chief, John D. Northrop.

Chief clerk, Elsie Patterson.

Division of mineral classification: J. D. Northrop, geologist, chief; C. D. Avery, mining engineer; W. W. Boyer, geologist; G. W. Holland, classifier.

Division of hydrographic classification: W. G. Hoyt, hydraulic engineer, chief. Power section: B. E. Jones, hydraulic engineer, chief; N. J. Tubbs, engineer; E. E. Jones and R. O. Helland, classifiers; Warren Onkey, assistant engineer. Irrigation section: J. F. Deeds, hydraulic engineer, chief; C. E. Lordeen, topographic engineer; W. N. White, classifier.

Division of homestead classification: A. E. Aldous, classifier, chief; J. G. Mathers, engineer; W. L. Hopper, classifier.

In addition, two engineers, R. W. Davenport and D. J. Guy, were detailed from the branch for duty with the Federal Power Commission during the entire year, and 8 classifiers on the rolls of the water-resources branch were added to the staff of the land-classification branch during the office season in connection with homestead-classification work.

During the fiscal year there were 4 additions to the force and 6 separations. At its end the staff numbered 46, including the clerical force and employees detailed to the Federal Power Commission.

SCOPE AND CHARACTER OF THE WORK

During the year the land-classification branch performed the duties of the Geological Survey relating to "the classification of public lands" with which the Director of the Survey is charged by law. The field of its work is coextensive with the public domain of the United States, including Alaska.

The results of the work of the land-classification branch are utilized mainly in the preparation of orders for the withdrawal from entry, restoration to entry, classification, and designation of the public lands, of informative and advisory reports, and of recommendations for appropriate action concerning public lands, made chiefly to the General Land Office, the Secretary of the Interior, the Office of Indian Affairs, and the Federal Power Commission.

FUNDS

The current appropriation of \$280,000 for land classification prior to June 30, 1924, is an increase of \$55,000 over the appropriation for the preceding year but still \$20,000 below the appropriation available during the year ended June 30, 1922. Of the sum appropriated about 35 per cent was utilized for administrative and office expenses and the remainder for field investigations.

CORRESPONDENCE

During the year 15,316 letters and petitions were received by the land-classification branch. In addition, 5,000 copies of miscellaneous correspondence were sent to the branch for its information and filing. The correspondence was made up largely of letters from the General Land Office to its local officers and of reports on the character of lands by its inspectors and examiners, copies of decisions rendered by the Department of the Interior, and copies of withdrawals and restorations recommended by the Bureau of Reclamation. Within the same period 12,054 letters were prepared by the branch. These figures show an average of 50 incoming letters and of 40 outgoing letters for each working day of the year.

SUMMARY OF CASES

The information supplied concerning land classification is furnished either in reports made in response to specific requests for action on cases presented or in the form of broad areal classifications. The following table, which gives a summary of the cases presented and acted on during the year, shows that reports were made on nearly 15,000 specific requests. The mere number of cases disposed of, however, is not a true index to the magnitude of the work done, for some cases require only a few minutes' consideration, whereas others require exhaustive study and research, extending

ays or weeks, and some necessitate field investigations. The "gain" and "loss" in the table signify, respectively, decrease or increase in the number of cases pending.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1923-24						Record since receipt of first case	
	Pending July 1, 1923	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1924	Gain or loss during fiscal year	Received	Acted on
and Office requests.....	483	1,329	1,812	1,583	229	+254		
ns for classification as to								
al.....	18	3	3	3	0	+9	3	3
.....	119	895	1,014	837	177	-58	756	747
hate.....	1	3	4	2	2	-1	3,273	3,096
ns for mineral permits.....	619	6,607	7,226	6,019	1,207	-568	33	31
ns for mineral leases.....	35	247	282	262	20	+15	27,336	26,129
ns for patent, potassium.....	2		2	1	1	+1	707	687
ower Commission cases:							17	16
inary permits.....	1	6	7	6	1		46	45
es.....	1		1		1		12	11
ninations under sec. 24.....	7		7	7		+7	61	61
ns for reclassification as								
resources.....	7	6	13	6	7		634	627
ns for rights of way.....	28	106	224	192	32	-4	5,435	5,403
project reports.....	4	8	12	8	4		880	876
ns under enlarged-home-								
s.....	578	585	1,163	822	341	+237	54,907	54,566
ns under stock-raising								
ad act.....	2,954	3,812	6,766	4,929	1,837	+1,117	100,282	107,445
ns under ground-water								
ion act.....	45	58	103	66	37	+8	752	715
ice requests for information	3	4	7	6	1	+2	9,490	9,489
ational forests.....	1	10	11	11		+1	293	293
	4,906	13,782	18,688	14,782	3,906	+1,000		

DIVISION OF MINERAL CLASSIFICATION

work of the division of mineral classification involves, first, withdrawal, classification, and restoration of public lands according to their mineral character; second, the solution of geologic and economic problems arising in connection with the leasing of public lands; and third, the preparation of reports showing the mineral character of specific lands for the information and guidance of Government bureaus charged with the administration of public and Indian land laws.

approval of the potash-land leasing act in October, 1917, and the general mineral-lands leasing act in February, 1920, opened to leasing the deposits of coal, oil, gas, phosphate, oil shale, sodium, and potash in some 50,000,000 acres that were then embraced in outstanding mineral-land withdrawals, but it did not obviate the necessity of the classification of these lands and their restoration to the public domain. To this unfinished task the mineral division is devoting as much energy as is permitted by the limitations imposed on it by small personnel, inadequate geologic information, and pressure of other urgent work. The results accomplished in the fiscal year

include a net increase of 1,812,685 acres in the total area classified as coal land and of 4,105 acres in the total area classified as oil land and a net decrease of 2,998,210 acres in the area of outstanding coal withdrawals and of 421,723 acres in the area of outstanding petroleum withdrawals. No change was made during the year in areas previously withdrawn or classified as oil-shale land or in areas classified as phosphate land or included in potash reserves.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications, June 30, 1924, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash withdrawn
	Withdrawn	Classified as coal land	Withdrawn	Classified as oil land	Withdrawn	Classified as oil-shale land	Withdrawn	Classified as phosphate land	
Alaska		55,993							
Arizona	139,415		230,400						
Arkansas		61,160							
California	17,603	8,720	1,178,392						90,618
Colorado	4,241,552	3,170,566	222,977		41,560	952,239			
Florida							84,842		
Idaho	4,761	4,603					720,534	267,723	
Louisiana			466,990	4,105					
Montana	8,455,506	8,419,065	1,350,426	42,097			287,883		
Nevada	83,673				123				38,422
New Mexico	5,158,680	567,924							
North Dakota	5,954,364	11,178,286	84,894						
Oregon	4,361	18,887							
South Dakota		250,093							
Utah	4,258,519	1,101,867	1,870,627		86,584	2,705,085	302,465		
Washington	691,801	141,444							
Wyoming	2,358,563	6,736,183	597,175			460,103	995,049	25,298	
	31,368,798	31,715,791	6,001,881	46,202	128,267	4,117,377	2,390,773	293,015	129,940

The contributions made to the administration of the mineral-lands leasing laws with respect to coal involve the determination whether a prospecting permit or a lease should be issued, and, if a lease is required, the establishment of a leasing unit consistent in area and content of coal with the mining operation to be undertaken and the recommendation of appropriate stipulations as to royalty, minimum investment, and minimum annual production. Those made with respect to oil and gas involve the definition of the "known geologic structure" of producing oil or gas fields as the primary distinction between leasing and prospecting areas, the determination of the structural relations of lands embraced in prospecting permit applications, and the classification of all tracts included in such applications that are involved in unperfected entries under the nonmineral-land laws. Similar types of service involving decisions based on geologic evidence are rendered in the administration of the potash-land leasing law and the sections of the general mineral-lands leasing law pertaining to phosphate, oil shale, and sodium.

The following table summarizes the results of the year's work to the extent that they involve the consideration of specific applications for permit or lease rights under the leasing laws:

Applications made, acted on, and pending under the mineral-leasing acts, fiscal year 1923-24

Mineral	Permits			Leases			Patents		
	Re- ceived	Acted on	Pend- ing	Re- ceived	Acted on	Pend- ing	Re- ceived	Acted on	Pend- ing
Oil and gas.....	6,290	5,655	1,171	39	43	1			
Coal.....	255	302	36	198	205	16			
Phosphate.....				9	8	2			
Sodium.....	9	9							
Potassium.....	53	53						1	1
Oil shale.....				1	6	1			
	6,607	6,019	1,207	247	262	20		1	1

The work done under the leasing laws was restricted almost entirely to the designation of boundaries of the "known geologic structure" of producing oil and gas fields—that is, the designation of lands that are subject to lease only as distinguished from those on which prospecting permits may be granted. The results included definitions of the Hamilton (Moffat) and Wellington oil and gas fields, Colo.; the Aztec gas field, N. Mex.; the Alkali Butte and Notches oil fields and Boone Dome gas field, Wyo.; the Woodside gas field, Utah; and an extension of the Buena Vista Hills oil field, Calif.; and a revision of a definition of the Elk Hills field, Calif.

Reports made in response to requests of the General Land Office and the Office of Indian Affairs for information concerning the mineral character of specific lands have been kept up to date. There was a net reduction of 254 cases involving reports to the General Land Office and of 2 cases involving reports to the Office of Indian Affairs.

The work done involved the planning and financing of field surveys, both reconnaissance and detailed, which were made by the geologic and topographic branches.

The larger items of field work thus undertaken during the year to meet the specific needs of the land-classification branch and financed in whole or in part by allotments from funds appropriated for the classification of lands include (1) general geologic investigations in Blaine, Fergus, and Rosebud counties, Mont.; in Routt and Delta counties and along the east front of the Rocky Mountains, Colo.; in the Book Cliffs, Wasatch Plateau, and San Rafael districts, Utah; in the Powder River, Great Divide, and Snake River basins and the Rock Springs and Black Hills uplifts, Wyo.; in the Paradise Valley and Portneuf districts, Idaho; and in the Cold Bay region, Alaska; (2) detailed investigations of deposits of coal, oil, gas, and phosphate requisite to recommendations as to action on applications made under the leasing laws for lands in the States mentioned and in Oklahoma and New Mexico; and (3) core-drill prospecting of certain lands in Florida, undertaken to permit their classification with respect to phosphate.

DIVISION OF HYDROGRAPHIC CLASSIFICATION

POWER SECTION

The work of the power section consists primarily in obtaining and making available for use in the administration of the public-land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public-land laws. An endeavor is made to determine the proper administrative action by which the possibility of developing power may be preserved with minimum interference with agricultural, transportation, or other interests. In the course of this work a review of all power reserves is carried on in order that all land having primary value for the development of power, and only such land, shall be reserved for that purpose. The extent of this task is indicated by the fact that areas aggregating between four and five million acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the field branches of the Survey. The larger items of field work done to obtain information for power classification undertaken and in progress during the year at the request of the land-classification branch and financed by allotments from funds appropriated for the classification of lands include (1) plan and profile surveys and power-site investigations on Colorado River through Glen, Marble, and Grand canyons in Arizona, Utah, and California; on Rogue River and its larger tributaries and on Umpqua River and its larger tributaries in Oregon; on Clearwater River in Idaho; on streams in the Uinta River basin, Utah; and on Klamath River in Oregon and California; (2) detailed studies of the possibilities of developing power on the western tributaries of South Platte River in Colorado, on Sweetwater and Encampment rivers in Wyoming, and on Madison, Beaverhead, Bighole, and Jefferson rivers and a part of South Fork of Flathead River in Montana.

The information obtained is indexed and incorporated in an inventory of water resources, which, when complete, will enable the Survey to give competent advice on short notice as to the manner in which each tract of public land having value for power can be best used in connection with the development of water power and as to the relation of such use to other possible uses of the tract. Copies of many of the reports made on the power possibilities of the streams examined have been placed in the district offices of the Survey for public inspection, and notices of the availability of the reports have been sent to the press.

The work done in the section is briefly summarized in the following tables showing power-site reserves, outstanding water resources, and agricultural withdrawals and classifications, and in the table, already presented, giving a general summary of cases involving land classification.

Pursuant to the instructions of the Secretary of the Interior dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted by the Secretary since January 1, 1913, were called upon for detailed reports of the operation or development of their power systems during the calendar year 1923. The total installation of the reporting companies is 1,574,000 kilowatts, of which 1,271,000 kilowatts is installed at hydraulic plants. The total energy generated amounted to 5,910,000,000 kilowatt-hours, of which 5,245,000,000 kilowatt-hours was generated by water power. The operating expenses of the companies generating 100,000,000 kilowatts or more (90 per cent of which was generated by water power), including taxes and depreciation, averaged 9.22 mills per kilowatt-hour installed. The gross income from the electrical operations of the same companies was 14.7 mills per kilowatt-hour of energy sold.

Power output of permittees and grantees, 1916-1923

Year	Number reporting	Kilowatt-hours	Increase or decrease	
			Kilowatt-hours	Per cent
1916	26	1,200,000,000		
1917	32	2,000,000,000	+800,000,000	+67
1918	51	3,200,000,000	+1,200,000,000	+60
1919	57	3,100,000,000	-100,000,000	-3
1920	56	4,200,000,000	+1,100,000,000	+35
1921	59	3,725,000,000	-475,000,000	-11
1922	59	4,947,000,000	+1,222,000,000	+33
1923		5,910,000,000	+963,000,000	+19

Power-site reserves, in acres

Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction.]

State	Reserved prior to July 1, 1923	Eliminated prior to July 1, 1923	Reserves outstanding prior to July 1, 1923	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1924
Alabama	749		749			749
Alaska	168,241	520	167,721	267		167,988
Arizona	1,161,710	105,194	1,056,516	1,453	8,000	1,049,969
Arkansas	29,469		29,469	82		29,551
California	953,072	18,252	934,820	42,282	1,007	976,095
Colorado	342,406	48,254	294,152	11,103	6,879	298,376
Florida	496		496			496
Idaho	440,936	172,467	268,469	9,943	11,753	266,659
Michigan	1,240		1,240			1,240
Minnesota	12,841	532	12,309	48		12,357
Montana	283,581	78,486	205,095	16,051	6,316	214,830
Nebraska	761		761			761
Nevada	300,422	280	300,142	328	200	300,270
New Mexico	215,181	6,537	208,644		1,096	207,548
Oregon	512,295	78,802	433,493	40,190	6,446	467,237
South Dakota	12		12			12
Utah	588,672	120,812	467,860	3,046	2,228	468,678
Washington	178,441	41,005	137,436	22,947	9,202	151,181
Wisconsin	1,096	226	870			870
Wyoming	217,083	67,998	149,085	5,312	5,410	148,987
	5,407,694	739,365	4,668,329	153,052	58,537	4,762,844

*Summary of outstanding water-resources withdrawals and classifications,
June 30, 1924, in acres*

State	Power reserves					Reser- voir with- drawals	Public water with- drawals	Ground- water reclama- tion designa- tions
	With drawals	Classifi- cations	Designa- tions *	Miscel- laneous	Total			
Alabama.....	120	190		439	749			
Alaska.....	93,415	3,478		71,095	167,988			
Arizona.....	302,208	37,182	528,245	182,334	1,049,969	23,040	14,646	
Arkansas.....	22,354	1,590		4,607	28,551			
California.....	296,178	78,614		601,303	976,095	1,160	167,371	
Colorado.....	252,560	18,684		27,132	298,376	1,728	1,740	
Florida.....				496	496			
Idaho.....	212,936	47,229		6,494	266,659		12,080	
Michigan.....	1,240				1,240			
Minnesota.....	12,309			48	12,357			
Montana.....	141,521	51,271		22,038	214,830	9,080	7,297	
Nebraska.....	761				761			
Nevada.....	27,492	27,786		244,992	300,270		10,086	1,425,060
New Mexico.....	64,387		143,161		207,548		3,316	
North Dakota.....						1,569		
Oregon.....	395,215	24,356	15,891	31,775	467,237	10,619	15,951	
South Dakota.....				12	12		240	
Utah.....	445,082	4,329		19,067	468,678	80	33,485	
Washington.....	100,136	26,294		24,751	151,181	35,943	920	
Wisconsin.....				870	870			
Wyoming.....	82,829	25,621		40,537	148,987	1,714	81,505	
	2,450,743	346,824	687,297	1,277,980	4,762,844	84,933	353,637	1,425,060

* Designated and not otherwise withdrawn for power purposes.

IRRIGATION SECTION

The work of the irrigation section includes the classification of lands under the enlarged and stock-raising homestead laws as non-irrigable; the classification of lands under the Nevada ground-water reclamation act as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public-land laws; and the initiation of withdrawal of lands for reservoir sites. Applications for classification are disposed of according to the results of examination made by the field branches of the Survey and information gathered from other sources showing water supply and adaptability to irrigation. Many applications involve the classification of large areas, and such broad classifications serve to govern action on new applications for the classification of land in the same areas. Thus broad field studies are planned in critical areas for execution by the field branches and financed by allotments from the funds appropriated for the classification of lands. During the year such studies were in progress at the headwaters of Missouri River in Montana, in the drainage areas of Red Rock, Beaverhead, Bighole, Jefferson, and Madison rivers; along Missouri River from Fort Benton to the Montana-North Dakota State line; and in Escalante Valley, Utah. Additional field studies were undertaken in scattered small tracts throughout the public-land States.

During the year the area of land designated under the Nevada ground-water reclamation act as a result of the work of the section was increased from 1,300,940 to 1,425,060 acres. Other results of

the work are shown briefly in the tables relating to enlarged and stock-raising homestead designations and general summary of cases.

Summary of enlarged-homestead designations, in acres

Areas classified as arid and nonirrigable, residence by entrymen required, under act of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat., 531), applicable to Idaho; act of June 13, 1912 (37 Stat., 132), applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat., 953), applicable to Kansas; act of Mar. 4, 1915 (38 Stat., 1163), applicable to South Dakota. Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required, under act of Feb. 19, 1909 (35 Stat., 639), applicable to Utah; act of June 17, 1910 (36 Stat., 531), applicable to Idaho.]

State	Designations prior to July 1, 1923	Cancellations prior to July 1, 1923	Designations outstanding prior to July 1, 1923	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1924
Arizona.....	31,250,969	5,409,474	25,841,495	95,680	120	25,937,055
California.....	13,090,686	28,320	12,852,345	48,108	133	12,941,321
Colorado.....	33,127,476	184,988	32,942,488	278,010		33,211,098
Idaho:						
Total.....	13,505,201	456,285	13,048,916	38,027	a 1,840	13,083,103
Nonresidence.....	567,227	4,233	562,994	2,400		565,394
Kansas.....	644,074		644,074	1,060		646,034
Montana.....	53,104,485	244,282	52,950,203	110,470	1,446	53,056,227
Nevada.....	50,120,150	3,564,797	46,555,353			46,555,353
New Mexico.....	43,414,844	227,732	43,187,112	302,401		43,489,513
North Dakota.....	12,267,710	3,848	12,263,862	3,395		12,267,257
Oregon.....	21,208,324	889,462	20,318,862	46,410		20,265,272
South Dakota.....	16,324,535	348,170	15,976,365	6,053		15,982,418
Utah:						
Total.....	11,243,559	383,095	10,860,464	38,681	a 9,120	10,940,025
Nonresidence.....	1,601,254	22,800	1,578,454	23,126		1,601,680
Washington.....	6,595,005	251,842	6,343,163	40,395		6,383,558
Wyoming.....	29,048,148	161,684	28,886,464	290,259	80	29,176,643
	335,035,146	12,403,979	322,571,167	1,379,449	12,739	323,937,677

a Previously designated under secs. 1-5, now designated under sec. 6.

DIVISION OF HOMESTEAD CLASSIFICATION

The stock-raising homestead law requires that prior to entry under its terms land shall be classified as nontimbered, nonirrigable, valuable chiefly for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family. The division of homestead classification determines what lands shall be so classified, except as to irrigability, which is determined by the division of hydrographic classification. Field examination of individual tracts by the water-resources branch is planned by this division and financed by allotments from the funds appropriated for the classification of lands. Broad areal classification after general reconnaissance is made wherever practicable, in order to reduce the number of detailed field investigations to a minimum.

Under instructions of the Secretary of the Interior the division is cooperating with the Department of Agriculture in preparing a report on the agriculture and the utilization of land in the northern Great Plains region.

The work of this division includes also the reservation and restoration of tracts valuable for watering stock. During the year the additions to public water reserves embraced 125 acres in Arizona, 104,960 acres in California, 80 acres in Idaho, 360 acres in Montana, 70 acres in New Mexico, 1,640 acres in Oregon, 109 acres in Utah, and 40 acres in Wyoming, and the cancellations of such reserves included 5,777 acres in California, 80 acres in Colorado, 326 acres in

Montana, 40 acres in Nevada, 120 acres in New Mexico, and 444 acres in Wyoming. The areas remaining reserved as public watering places at the end of the year are shown in the table of outstanding water-resources and agricultural withdrawals and classifications.

The following summary of stock-raising homestead designations shows in detail other features of the progress of the work of this division, which has been kept substantially current throughout the year.

Summary of stock-raising homestead designations, in acres

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres are reasonably required for the support of a family. Act of December 29, 1916 (39 Stat. 862)]

State	Designations prior to July 1, 1923	Cancellations prior to July 1, 1923	Designations outstanding prior to July 1, 1923	Designations during fiscal year 1924	Cancellations during fiscal year 1924	Designations outstanding June 30, 1924
Arizona.....	13,779,110	832,200	12,946,910	88,312		13,035,222
Arkansas.....	1,120		1,120			1,120
California.....	7,529,930		7,529,939	80,933		7,610,863
Colorado.....	7,478,952	9,240	7,469,712	469,253		7,938,965
Idaho.....	5,041,035	1,134	5,039,901	104,986	640	5,144,247
Kansas.....	107,859		107,859	1,440		109,299
Michigan.....	2,951		2,951	500		3,451
Minnesota.....						
Montana.....	14,543,978	17,041	14,526,937	277,278	40	14,804,175
Nebraska.....	180,255		180,255	1,779		182,034
Nevada.....	434,125	2,800	431,325	36,815		468,140
New Mexico.....	30,839,355	600	30,838,755	160,171		30,998,926
North Dakota.....	354,430		354,430	8,755		363,185
Oklahoma.....	67,111		67,111	6,090		73,201
Oregon.....	6,036,989	2,408	6,034,581	106,264		6,140,845
South Dakota.....	6,437,247	550	6,436,697	17,427		6,454,124
Utah.....	1,080,482	860	1,079,602	96,748		1,176,350
Washington.....	638,533	1,134	637,399	9,550		646,949
Wyoming.....	19,325,090	4,934	19,320,156	326,140	80	19,646,216
	113,858,552	872,921	112,985,631	1,801,441	760	114,786,312

PUBLICATION BRANCH

DIVISION OF BOOK PUBLICATION

SECTION OF TEXTS

During the year 27,981 pages of manuscript were edited and prepared for printing, and proof sheets comprising 2,306 galley proofs and 15,928 page proofs were read and corrected. Indexes were prepared for 25 publications, covering 4,455 pages. Copy and proof or stencils for 620 pages of multigraph and mimeograph matter were read. The book publications of the year are listed and abstracted on pages 8-13.

At the end of the fiscal year 5 persons were employed in this section. The water-resources branch has continued to render special assistance in preparing copy and reading proof.

SECTION OF ILLUSTRATIONS

The number of drawings prepared was 4,442, including 166 maps, 1,031 sections and diagrams, 349 photographs, and 2,896 paleontologic drawings; 119 miscellaneous jobs were also done by the section. The

illustrations transmitted to accompany manuscripts numbered 873, to be reproduced by chromolithography, photolithography, halftone, zinc etching, and cuts already engraved. The number of proofs received and examined was 575. At the end of the year material for illustrating 37 reports was on hand. The section now consists of 10 employees.

DIVISION OF MAP EDITING

SECTION OF GEOLOGIC EDITING OF MAPS AND ILLUSTRATIONS

During the year 5 geologic folios were in hand. Four of these were completed and published. (See p. 13.) The maps of the Black Hills folio were printed and part of the text was in galley proof at the end of the year. The boundaries and letter symbols for the geologic map of Wyoming were drawn and prepared for photolithography. The boundaries and letter symbols of the geologic map of Arizona were prepared and engraved and transferred to stone, and the color sheets were prepared. The geologic map of Oklahoma, which is being compiled by others, was examined in cooperation with the compilers. The compilation of the geologic map of Texas was begun, and work was done on the geologic map of the United States. Illustrations for 32 reports of the Survey were critically examined and edited in the section. Some of these illustrations were drawn in the section, and several geologic maps for reports not yet transmitted were compiled and drawn in the section.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

During the year 90 topographic maps were edited and transmitted for engraving, 222 published topographic maps were edited for reprint, 54 plan and profile river-survey sheets were edited for photolithography, 3 miscellaneous maps were edited for engraving or photolithography, and 249 maps were edited as illustrations for Survey reports, a total of 618 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 424 and proofs of maps reproduced by photolithography numbering 189 were read. At the end of the year 87 new topographic maps were in process of engraving and printing. Index maps for 18 State circulars were revised and proofs corrected.

DIVISION OF DISTRIBUTION

During the year the division received 114 new books and pamphlets, 2 reprinted books and pamphlets, 4 new geologic folios, 12 new geologic maps, 92 new or revised topographic and other maps, and 203 reprinted topographic and other maps. A number of special pamphlets and forms prepared for administrative use were also received and distributed. The total units of all publications received numbered 351,107 books and pamphlets, 15,485 geologic folios, 1,777 geologic maps, and 970,804 topographic and other maps, a grand total of 1,339,173.

The division distributed 521,548 books, 16,681 folios, 923 copies of the World Atlas (555 of Part I and 368 of Part II), and 735,573 maps, a total of 1,274,725, of which 8,263 folios, 692 copies of the World Atlas (457 of Part I and 235 of Part II), and 608,436 maps

were sold. The sum received and deposited in the Treasury from the sale of publications was \$41,690.31, including \$39,383.01 for topographic and geologic maps, \$1,329.10 for geologic folios, and \$978.20 for copies of the World Atlas. In addition, \$990.19 was paid by other establishments of the Federal Government for maps or folios furnished by request. The total receipts, therefore, were \$42,680.50. The division received and answered 87,502 letters.

DIVISION OF ENGRAVING AND PRINTING

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the fiscal year 70 new topographic maps were engraved and printed, including a revised edition of the Brownsville (Kentucky) map, and 22 new maps were photolithographed and printed, making a total of 92 new maps printed and delivered. Corrections were engraved on the plates for 214 maps. Photolithographic reprints of editions of 193 topographic maps and of 10 corrected State and other maps were delivered. In addition, 32 new topographic maps were engraved but had not been printed by June 30, and the engraving for 9 more new topographic maps was nearly completed.

Of new and reprinted maps 295 different editions, amounting to 970,804 copies, were delivered.

Four new geologic folios were printed, in editions amounting to 15,485 copies. Twelve extra geologic maps of these folios, numbering 1,777 copies, were also delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, for the office of the Secretary of the Interior, for the Bureau of Mines, Bureau of Reclamation, Bureau of Education, National Park Service, Office of Indian Affairs, General Land Office, Bureau of Public Roads, Bureau of Plant Industry, Bureau of Agricultural Economics, Forest Service, Bureau of Standards, Bureau of Foreign and Domestic Commerce, Bureau of Lighthouses, Department of Labor, Department of Justice, Department of State, War Department, Post Office Department, Interstate Commerce Commission, United States Coal Commission, Federal Power Commission, International Boundary Commission, Alaskan Engineering Commission, Commission of Fine Arts, Federal Fuel Distributor, Federal Board for Vocational Education, and Veterans' Bureau. This work done for other branches of the Government included many reprints, and the charges for it amounted to about \$120,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the Treasury Department. Work amounting to \$4,643.79 was done on a topographic map of Arizona for the Bureau of Mines of that State, the employees of the Survey having been placed on an Arizona pay roll.

Transfer impressions numbering 264 were made during the year, including 125 furnished to contracting lithographic printers on requisition of the Government Printing Office, 103 furnished to private firms, 9 furnished under cooperative agreements to State geological surveys, and 27 furnished to the War Department. Other miscellaneous work was done for the Anthracite Bureau of In-

formation, Idaho Bureau of Mines, Des Moines Joint Stock Land Bank, The Military Engineer, Rider's Guides, and the World Book Co. The amount turned over to miscellaneous receipts from this work was \$497.79.

Of contract and miscellaneous work of all kinds, 3,667,916 copies were printed. Including topographic maps and geologic folios, a grand total of 4,655,982 copies were printed and delivered. As most of this work was in colors, involving many separate printings, the total number of impressions was about 23,000,000.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 14,008 negatives (1,644 wet, 246 paper, 3,026 dry, 4,550 field negatives developed, and 4,542 photolithographic negatives), 1,609 lantern slides, 111,037 prints (72,165 maps and diagrams, 34,518 photographs for illustrations, and 4,354 rectigraphs), 3,744 zinc plates, 270 zinc etchings, 105 celluloid prints, 341 lantern slides colored, and 1,387 prints mounted.

ADMINISTRATIVE BRANCH

EXECUTIVE DIVISION

During the year 138,310 pieces of mail, of which 2,535 were registered, were opened and referred, and 1,000 letters and cards were received in connection with the revision of mailing lists. In addition 210,051 letters were received directly by other divisions, making a total of 348,361, an increase of 3 per cent over the total in 1923. Of the letters opened in this division 19,624 contained money remitted for Survey publications. The ordinary letters mailed through the division numbered 95,623, the registered letters and packages 17,990, and the form letters, etc. (addressograph section), 475,000. In addition 294,566 pieces of mail were sent out directly from other divisions. The total number of outgoing pieces of mail from the Geological Survey was 883,179.

During the year 3,505 pieces of freight and express were handled, 1,294 outgoing and 1,211 incoming.

The Secretary's appointees at the end of the fiscal year numbered 928, 13 more than at the end of the fiscal year 1923. The total number of changes in personnel was 489, which included 170 appointments, 157 separations, and 162 miscellaneous changes.

During the calendar year 1923 16,663 days of annual leave and 4,165 days of sick leave were granted—about 72 per cent of the annual leave and 18 per cent of the sick leave that could have been granted to an average of 768 employees entitled to leave. Leave without pay and furlough amounting to 5,176 days was also granted.

The clerical personnel of the division consisted of 29 employees, 15 of whom were employed in the addressograph section. In addition there were 2 general laborers, a chief messenger, and 9 messengers, a total of 40.

DIVISION OF SCIENTIFIC AND TECHNICAL EQUIPMENT

The work of the division of scientific and technical equipment consists of the receipt, custody, and shipment of field property, the repair of instruments, the inspection and repair of all electric apparatus, and the execution of cabinet and carpenter work. Records are kept of all camp equipment, such as livestock, automobiles, and instruments. In this work 7 persons were employed. The express and freight handled during the year weighed approximately 77,000 pounds.

LIBRARY

The accessions to the library numbered 13,962 books, pamphlets, and periodicals and 693 maps. The recorded loans were 6,762 books and 292 maps, not including those used by 12,908 readers who consulted the library in person. The catalog was increased by the addition of 7,920 cards. In accordance with the cooperative cataloging arrangement 469 title entries were furnished to the Library of Congress for printing, the proof reading for which involved 111 galleys.

The correspondence, consisting of 2,225 letters written and 2,356 received, concerned chiefly the exchange of publications. The foreign articles and letters translated for other divisions of the Survey numbered 230. There were 1,200 books collated and prepared for binding and 1,589 newly bound books accessioned and labeled.

Continued calls are received from other parts of the country for the loan of publications that are available only in this library. The library is cooperating in the compilation of a union list of serials in the libraries of the United States, which is to be published under the auspices of the American Library Association.

The bibliography and index of geologic literature on North America, 1785-1918, were proof read and have been issued as Bulletins 746 and 747. The bibliography of North American geology for 1921-22 (Bulletin 758) was prepared and proof read.

DIVISION OF ACCOUNTS

Condensed statements covering the expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1924^a

Appropriation	Funds available				Expenditures			Balance	
	Amount of appropriation	Repayments on account of work performed			Total	Disbursements	Outstanding liabilities		Total
		For other Government establishments		For other Geological Survey units					
		Made	To be made						
Salaries.....	\$50,000.00	\$122.22	881.26		\$50,883.47	\$49,305.26	\$1,588.21		
Topographic surveys.....	500,000.00	32,349.57	2,888.42	\$17,721.21	532,968.30	\$7,268.23	550,897.28		
Geologic surveys.....	300,000.00	5,342.07	571.36	742.48	305,655.91	2,458.46	300,619.03		
Chemical and physical researches.....	40,000.00				40,000.00	716.60	39,563.85		
Preparation of illustrations.....	18,280.00	48.96			18,328.96		18,314.96		
Mineral resources of the United States.....	124,250.00	1,450.15		100.00	125,800.15	508.91	124,850.50		
Mineral resources of Alaska.....	75,000.00	1,528.42		41.38	76,570.80	9,082.92	76,488.57		
Gaging streams.....	170,000.00	41,060.79	4,607.04	10.63	215,678.45	976.46	213,871.94		
Books for the library.....	2,000.00				2,000.00	1,997.57	2.43		
Geologic maps of the United States.....	110,000.00	85,680.63	7,871.26	22,532.36	227,084.24	3,877.18	226,323.47		
Classification of lands.....	280,000.00	804.48	310.96	666.12	281,786.56	5,927.85	275,065.88		
	1,670,190.00	168,394.29	16,330.30	42,814.17	\$1,897,728.76	31,078.55	\$1,877,896.31		
							20,862.45		

^a In addition to these appropriations, items of \$110,000 for printing and binding Survey publications and \$10,000 for miscellaneous printing and binding were contained in the appropriation for that purpose, the accounts for which, however, were not kept in the Geological Survey. There was also an allotment of \$4,280.70 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

^b Included in this amount is \$42,814.17 covering work performed by Survey units for other Survey units, necessarily reported in combining totals but otherwise a duplication.

^c Of this total, \$11,477.02 is in the hands of special disbursing agents and therefore has not been included in the classification of expenditures, as no vouchers covering disbursements have been received.

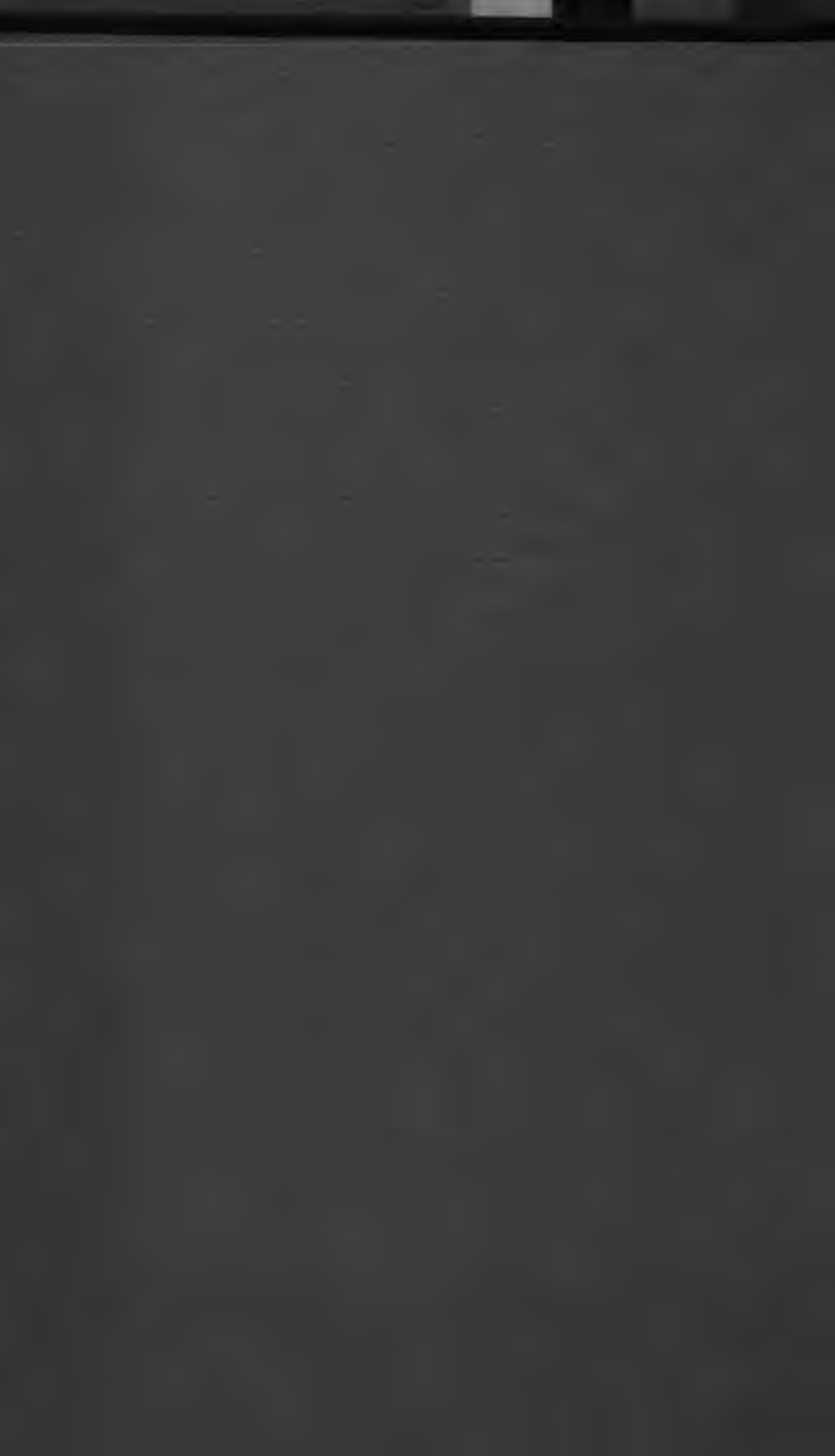
Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1924

Object of expenditure	Geological Survey salaries	Topographic surveys	Geologic surveys	Chemical and physical researches	Preparation of illustrations	Mineral resources of the United States	Mineral resources of Alaska	Gaging of streams	Books for the library	Geologic maps of the United States	Classification of lands	Total
Personal services.....	\$49,305.26	\$353,796.74	\$249,342.71	\$32,746.56	\$17,992.18	\$118,160.16	\$52,076.43	\$159,819.81		\$167,537.72	\$104,217.07	\$1,394,985.23
Stationery and office supplies.....		1,883.71	870.20	87.36	1.50	213.05	234.83	903.79		39,628.10	1,229.97	45,090.51
Scientific and educational supplies.....		844.86	1,767.13	2,159.11	43.64	353.91	247.03	1,216.77		1,985.64	214.46	8,815.54
Sundry supplies.....		4,998.46	565.05	106.70		55.31	103.31	2,068.99		6,739.49	898.11	15,645.45
Subsistence and care of animals, and storage and care of vehicles.....		1,415.05	738.24							150.16		2,304.45
Telephone service.....		627.74	170.68	1.79		882.87	112.59	248.34		4.82		2,298.23
Telegraph service.....		119.32	22.65	3.60		145.08	11.08	453.29				859.58
Other communication service.....				60				7.15				24.32
Travel expenses.....		109,554.39	18,839.19	1,583.97		2,669.00	10,428.80	21,434.57		53.88	41,463.21	206,042.11
Attendance at meetings.....		101.05	1,608.48					585.42			319.68	2,591.63
Hire, maintenance, operation, and repair of horse-drawn and motor vehicles.....												
Propelled passenger-carrying vehicles.....												
Transportation of things.....		8,338.75	1,398.84	6.00		146.88	94.00	3,981.41			5,170.96	19,136.34
Lithographing, engraving, and etching.....		20,111.18	3,360.19	541.77		157.16	1,683.04	2,310.83		43.40	8,456.20	34,618.77
Geographic work, typewriting, and duplicating work, etc. (Job work).....		6,348.51	1,896.52	13.24	8.29	499.53	629.93	742.98		215.21	50.83	10,495.04
Photographing and making photographs and prints.....		30.00	62.50				30.00	6.54			3.35	122.39
Rents.....		2,101.73	5,774.91	60.86	194.75	189.96	281.47	903.77			3,463.33	12,970.78
Repairs and alterations.....		19.32	96.90	8.14				1,815.00				1,930.36
Special and miscellaneous current expenses.....								223.35		427.30		650.65
Purchase of passenger-carrying vehicles.....		10,395.99	3,650.39	1,202.60	14.60	927.16	1,142.38	1,554.94		2,765.75	7,854.33	29,508.14
Furniture, furnishings, and fixtures.....		2,033.37	1,890.00					3,926.16			2,136.35	9,927.88
Educational and scientific equipment.....		2,408.59	166.17	21.40		428.80	751.13	134.80		41.96	592.99	4,543.84
Livestock.....		3,015.43	3,808.24	1,015.39	60.00	20.00	255.48	10,465.65		1,149.49	305.34	22,122.67
Other equipment.....		20,217.50	4,694.03	8.00			1,035.00	1,038.38			33.00	1,375.00
							463.09			5,746.71	5,776.67	37,956.38
	49,305.26	546,702.40	300,619.03	36,563.85	18,314.96	124,856.80	60,423.57	212,871.94	1,997.87	226,235.47	272,878.74	1,865,869.29

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DEPARTMENT OF THE INTERIOR

Hubert Werk, Secretary

U. S. GEOLOGICAL SURVEY

George Otis Smith, Director

FORTY-SIXTH ANNUAL REPORT

OF THE

DIRECTOR OF

THE GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1925



WASHINGTON
GOVERNMENT PRINTING OFFICE
1925

Directors of the Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-

GEORGE OTIS SMITH, 1907-

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Publication branch.....	
Division of book publication.....	
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Division of distribution.....	
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Administrative branch.....	
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ILLUSTRATION

PLATE I. Areas covered by topographic surveys made by United States Geological Survey prior to July 1, 1925.....

N. S. East
1-27-1926

ANNUAL REPORT

OF THE

DIRECTOR OF THE GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 14, 1925.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1925 included 10 items, amounting to \$1,735,423. In addition \$110,000, to be disbursed under the direction of the Public Printer, was appropriated for printing the reports of the Survey, and allotments of \$10,000 for miscellaneous printing and binding and of \$4,944.75 for miscellaneous supplies were made to the Survey from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of this report. The balance shown is \$15,175.31.

COOPERATION

Cooperation with the States and other public agencies continued as in other years. The value of the mapping and investigative work of the Survey and the necessity of expediting the completion of this physical inventory of the country's resources is now so widely recognized that 37 States as well as many counties and municipalities shared with the Federal Government in meeting the cost.

The total amount thus contributed was \$739,537.94. Funds aggregating \$231,208.90 were placed to the credit of the Geological Survey for services rendered to other Government bureaus and offices. Balances at the end of the year amounted to about \$15,000, and the total expenditure, measuring the amount of work accomplished during the year, was \$2,690,994.53.

GEOLOGY AND INDUSTRY

The "discovery" of geology during recent years by many branches of the mineral industry, notably the petroleum industry, is having a noticeable effect on geologic work in the United States. The most conspicuous immediate result has been to accent the economic applications of geology and to increase greatly the number of geologists professionally engaged in applying their science to the problems of oil discovery and mining. Early in this movement in the petroleum field the chief work was structural mapping, but with the rapid acquisition and drilling of the areas of easily recognized favorable structural conditions and the intensified struggle to find new pools the difficulties and refinements of the work have increased, and the

leaders among the oil geologists have broadened their activities and are seeking to utilize all applicable branches of geology and related sciences in their quest. There is an increasing demand for refined stratigraphic and paleontologic work. Isostatic, seismologic, and other physical methods are being applied, and the chemistry of waters and oils is investigated for any light it may throw on correlation, on the limits of pools, and on any other factors that may control or direct the search for oil.

There are comparable but less accentuated trends in other fields of economic geology. The United States has reached that point in the utilization of many of its mineral supplies where the easily discovered deposits are known and under development. It may indeed have already passed the peak of production in some of the most essential among these fundamental necessities of civilized life in its present form. The commercial world realizes this situation but dimly, if at all, but the technical staffs of the mineral industries are well aware that the task of finding reserves to keep the industries going is year by year becoming more difficult. This need stimulates the demand for any helpful information, and in this field geologic science is fundamental and its aid is being sought more and more. Furthermore, there is a growing recognition of the value of basic researches, which may throw light on the laws that control the occurrence of the useful minerals. The geologist in commercial work, though he may be finely trained and with splendid capacity, is usually so busily engaged in applying the known principles of his profession that he has little opportunity to develop new principles.

The research institutions having geologic staffs are, under these conditions, more and more expected to supply the basic geologic data needed in the development of our mineral resources. The details of small areas, such as mines or oil pools, can often be determined with entire adequacy by the practicing mining engineer or economic geologist, but accurate geologic maps of larger districts and determinations of the rock succession and the stratigraphic details, the large features of structure, the paleontology, the sources and extent of mineralization, and the rocks most likely to be affected by it—these are a few of the items in the regular work of the geologic branch that are in constant demand by geologists who are practicing their profession in the mining world.

The geologic staff of the Survey, with its associates in chemistry and physics, attempts to meet, within the limitations of men and means available, these needs of the economic group in the profession and at the same time to conduct a modicum of research for the general advancement of the science, as one of the important departments of human knowledge, which is doing its share to increase man's acquaintance with his environment, that he may adapt himself more successfully to that environment. Always, however, it is to be remembered that the pure research of to-day may find distinct application to-morrow. In this sense all the Geological Survey's work is economic.

SUMMARY OF THE WORK OF THE YEAR

The itemized summary of the principal features of the year's program of work is given below, and statements in detail may be found under the headings of the several branches of the Survey. Outstanding

ing items in the year's list of accomplishments were the continuation of exploration of Naval Oil Reserve No. 4 in arctic Alaska, the preparation for publication of the engineering results of the survey of the Colorado Canyon, and the publication of a geologic map of Wyoming. These three projects well illustrate the general purpose of all the investigative work.

The topographers and geologists in the Alaskan exploration are now filling in the largest blank space on the map and at the same time determining the degree of probability that here in arctic Alaska may be found petroleum to meet naval and other needs.

The issue, in October, 1925, of a water-supply paper on the water power and flood control of Colorado River makes available for use the results of a long series of river measurements and surveys by the Geological Survey. Projects for the control of this river and the development of its resources can now be discussed and undertaken with a knowledge of the engineering facts.

The geologic map of Wyoming, published this year, is a splendid example of map making and map printing. The knowledge of the geology of this State, largely gained through the earlier Federal surveys, has been greatly augmented in the last two decades by the detailed examinations of the public lands in the determination of their value for coal and oil, and making this general map available for the use of the many citizens who are actively engaged in the development of these resources is believed to be most opportune. Similar maps of Oklahoma and New Mexico are ready for engraving, and the whole western territory should be covered by geologic maps on the uniform scale of 8 miles to the inch. The State of Arizona, with the cooperation of the Federal Survey, has just issued such a map, and assistance has been given to Colorado and to Montana in similar projects.

WORK IN GEOLOGY

Made geologic surveys in 36 States and in Alaska, including geologic mapping, determination of stratigraphy, structure, and geologic history, and examination of mineral resources.

Cooperated with 13 States in geologic work.

Made special studies in 8 States in relation to oil and gas, in 6 States in relation to coal, in 2 States in relation to arsenic resources, and in 4 States in relation to phosphate deposits.

Continued study of the microorganisms of oil sands in connection with determination of underground structure.

Continued study of origin and distribution of oil shale and the nature of the contained organic material from which oil may be derived by distillation. Gained much information by microscopic, chemical, biologic, and botanic studies.

Completed three special field investigations in metalliferous geology in the Leadville district, Colo.; the copper region of Lake Superior; and the Mother Lode, Calif.

Prepared a geographic handbook and map of New England.

Cooperated with the Georgia Geological Survey in the publication of a report on the physical geography of Georgia; with the State of Virginia on a report on the Valley coal fields; with the State of Kansas on the geology and oil possibilities of Russell County, Kans.; and with 7 States in the preparation of their respective State geologic maps.

Cooperated with Indian Office concerning leasing of oil lands on Indian reservations, with the Forest Service in the examination of proposed extensions of national forests, and with the Bureau of Reclamation in the examination of reservoir and dam sites.

Published a new geologic map of Wyoming.

Continued investigations of potash deposits in Texas.
 Revised map of oil-shale reserves in Colorado for the Navy Department.
 Took over the work of the Hawaiian Volcanic Observatory.

WORK ON MINERAL RESOURCES

Cooperated with 14 States and with the Bureaus of the Census and Mines in the collection of mineral statistics.

Issued weekly reports on the production of coal, monthly reports on oil, and the usual number of annual reports.

Prepared for printing the report of the late United States Coal Commission.
 Worked on a world atlas on fuel reserves.

WORK IN CHEMISTRY AND PHYSICS

Made quantitative analyses and studies of 1,386 mineral specimens and identified 3,191 specimens for the public.

Continued analyses of potash samples from wells in Texas and Utah.

Continued investigations of the porosity of oil sands.

Conducted temperature tests of the deepest well in the world, 7,700 feet, near Long Bridge, Pa.

WORK IN ALASKA

Maintained 11 field parties in Alaska during the field season.

Continued geologic and topographic mapping and investigation of the mineral resources of the Territory, making geologic surveys, including reconnaissance and exploratory, of 23,080 square miles, and similar topographic surveys of 21,000 square miles.

Continued the survey of Naval Petroleum Reserve No. 4, in northern Alaska, for the Navy Department.

Arranged with the Bureau of Aeronautics for the airplane photographing of islands of southeastern Alaska in order to expedite topographic and geologic mapping of some 18,000 square miles of difficult territory, and cooperated with the General Land Office in making topographic surveys in southeastern Alaska.

TOPOGRAPHIC WORK

Surveyed for mapping 17,323 square miles in the United States, resurveyed 529 square miles, made river-profile surveys of 857 linear miles, and ran 7,170 linear miles of primary levels.

Established 1,872 permanent bench marks, occupied 113 triangulation stations, ran 4,429 miles of primary traverse lines, and set 1,109 permanent marks.

Mapped 481 square miles in Hawaii.

Published 75 new standard topographic maps, 42 river plans and profiles, advance photolithographs of 93 new topographic maps (to be engraved later), and 88 photolithographs of new topographic maps for which publication is not otherwise provided.

Cooperated in topographic mapping with 21 States and Hawaii, 7 counties, 1 municipality, and 7 Federal bureaus.

Constructed air-route maps for the Air Service, United States Army, from New Orleans to Beaumont, Tex.; from Iowa City, Iowa, to Omaha; and from Omaha to North Platte, Nebr.

WORK ON WATER RESOURCES

Continued stream measurements at 1,715 gaging stations in the United States and Hawaii, 30 States cooperating, to determine the quantity of water available for irrigation, power, industrial, municipal, and other uses.

Conducted underground-water studies in 19 States and Hawaii.

Made 364 water analyses.

Issued monthly and annual statements on the production of electricity and consumption of fuel by public-utility power plants; also a statement on the developed water power of the United States.

Made examinations of promising dam sites covering the 100-mile section of Colorado River between Pierces Ferry and the lower end of Black Canyon, Ariz.

Made surveys of the power and irrigation value of 6 tributaries of the Colorado, and completed 12 other similar river projects.

WORK IN CLASSIFICATION OF PUBLIC LANDS

Reported on 14,421 cases arising under the administration of the public-land laws.

Classified 159,040 acres of public land as coal land, 25,640 acres as prospective oil land, and 4,690 acres as phosphate land, and made other classifications resulting in net decreases of 509,729 acres in the total area withdrawn as possible coal land, of 55,418 acres in areas withdrawn as possible oil land, and of 334,941 acres in outstanding withdrawals for phosphate.

Recommended the addition of 27,880 acres to oil-shale reserves.

Reported on 6,443 applications for permits, leases, or patents under the mineral-land leasing laws.

Recommended the addition of 520,089 acres to the power-site reserves and the elimination of 35,753 acres.

Increased the area withdrawn under the Nevada ground-water reclamation act from 1,425,060 acres to 1,550,420 acres.

Recommended designations involving 534,869 acres of land available for settlement under the enlarged-homestead acts and the cancellation of designations involving 50,274 acres.

Recommended the addition of 3,055 acres to the public water reserves and the elimination of 1,555 acres.

Recommended the designation of 1,299,897 acres as stock-raising homestead land and the cancellation of designations covering 30,396 acres.

WORK IN PRINTING AND PUBLICATION

Edited and prepared for printing 20,372 pages of manuscript, and prepared indexes for 46 publications covering 9,689 pages.

Prepared 3,099 illustrations for reproduction in reports.

Edited for engraving 58 new topographic maps, 169 maps for reprinting, and 255 other maps.

Issued 187 books and pamphlets, including 10,966 pages; 131 new or revised maps; reprinted 158 maps—the editions aggregating 512,994 copies of books, 3,740 geologic maps and folios, and 765,323 topographic and other maps, a total of 1,285,057 copies.

Printed maps, folios, charts, etc., in a total of 3,727,389 copies, in part for other Federal offices.

Distributed 650,842 books, 10,027 geologic folios, and 729,154 maps, of which 612,016 maps and folios were sold for \$43,430.07.

WORK BY THE DIRECTOR

In addition to his administrative duties, the Director continued his service as chairman of the President's Naval Oil Commission and served in a somewhat similar capacity as chairman of the advisory committee selected by the four Cabinet officers forming the Federal Oil Conservation Board to assist them in their general study of the petroleum problem.

As in other years, some of the points of contact between the Survey's current work and the public are indicated by the following titles of addresses given by the Director and articles published during the year:

"Needed—a program for profits," International Petroleum Congress, Tulsa, Okla., October 7.

"Report on the London power conference," American Society of Mechanical Engineers, New York, November 20.

"Our mineral resources," National Crushed Stone Association, Cincinnati, Ohio, January 3.

"Power as labor's best friend," Industrial Foremen's Dinner, Worcester, Mass., January 23.

"Energy resources," Engineers' Club of Philadelphia, February 24.

Informal talks on the energy supply before the Churchman's Club and the Lions Club of Washington.

Two press memoranda on the use of electricity on European farms, giving personal observations in connection with attendance at the World Power Conference, London.

Interview on power, *New York Times*, September 7.

"What the Geological Survey is doing for the mining industry," *Mining Congress Journal*, October.

"Conserving our petroleum supply," *The Spur*, January 15.

"How will man's work be done?" *Colliers Weekly*, March 14.

PUBLICATIONS

The publications of the year consisted of 187 books and pamphlets of the regular series (including 2 reprints), 131 new or revised maps, 158 reprinted maps, and numerous circulars, lists of publications, etc. The total number of pages in the book publications was 10,966. Brief notices of these publications and descriptions of the areas represented by the new maps are given below, with the special purpose of showing the scope and character of the investigative work of the Geological Survey. The variety of the subjects treated and the mass of the resulting volumes, requiring more than 2 feet of shelf room for the year's product, explain why requests from individuals for all that the Survey publishes are no longer complied with. It is believed, however, that the descriptive notes given here will indicate the value of each volume or map to some large class of users.

FORTY-FIFTH ANNUAL REPORT of the Director of the United States Geological Survey to the Secretary of the Interior for the fiscal year ended June 30, 1924. 85 pp., 1 pl.

A detailed account of the work of the Geological Survey during the year.

PROFESSIONAL PAPER 92. The middle and upper Eocene floras of southeastern North America, by E. W. Berry. 212 pp., 65 pls., 9 figs.

Gives the results of several years of studies of the middle and upper Eocene fossil plants of the southern Coastal Plain, supplementing Professional Paper 81, which describes and interprets the extensive floras of the lower Eocene beds of the same region. This region is physiographically unique; it rivals the Paris Basin in the unity of its geologic history, in its stability in altitude, and in the abundance of its alternating marine faunas and terrestrial floras. Because of its large size, its proximity to the American Tropics, and its long, uniform, and relatively unbroken geologic record its fossil plants also furnish unique and invaluable suggestions as to the evolution and geographic distribution of floras.

PROFESSIONAL PAPER 127. The composition of the earth's crust, by F. W. Clarke and H. S. Washington. 123 pp.

A comprehensive statement, in general and in detail, of the mineral and elemental constitution of the crust of the earth. Considers broadly the character of the earth's crust and its interior, the general features of the igneous rocks that form the largest part of the crust, and the mineral constituents of those rocks.

PROFESSIONAL PAPER 132-F. Relations of the Wasatch and Green River formations in northwestern Colorado and southern Wyoming, with notes on oil shale in the Green River formation, by J. D. Sears and W. H. Bradley. 17 pp., 2 pls. (incl. 1 map), 2 figs.

Interest in the Eocene deposits of the Rocky Mountain and Plateau provinces has been stimulated by the discovery of vast quantities of oil shale in the Green River formation of Wyoming, Colorado, and Utah. This report describes the geologic relations of the Wasatch and Green River formations in a part of this area and draws conclusions as to their source of material, mode of origin, and other pertinent features. The method and place of deposition of the Green River formation which largely determine the relative richness of the oil shale, are clearly set forth and measured sections of the formation, with results of tests of the oil shale, are given.

PROFESSIONAL PAPER 132-G. Discovery of a Balkan fresh-water fauna in the Idaho formation of Snake River valley, Idaho, by W. H. Dall. 9 pp., 1 pl.

Describes a small fauna that contains some remarkable European forms hitherto unknown in the Western Hemisphere.

PROFESSIONAL PAPER 132-H. The resuscitation of the term Bryn Mawr gravel, by F. Bascom. 5 pp.

Gives a brief history of the nomenclature of the deposits in eastern Pennsylvania, Delaware, and Maryland known as the Brandywine formation.

PROFESSIONAL PAPER 132-I. Origin of the boghead coals, by Reinhardt Thiesen. 20 pp., 14 pls.

The boghead coals are close-grained brownish-black to black, very tough, elastic bituminous shales. Material of this sort is very rich in organic constituents and has been used in large quantities for the manufacture of kerosene that would not have the disagreeable odor of "coal oil." This paper gives the results of a study of boghead coals from New South Wales, Scotland, Alaska, and Pennsylvania. The author concludes that they consist largely of colonies of alga-like organisms heretofore not well known.

PROFESSIONAL PAPER 132-J. Aniakchak Crater, Alaska Peninsula, by W. R. Smith. 18 pp. (incl. title-page, contents, and index to volume), 4 pls., 1 fig.

Describes a gigantic crater that resembles in many respects that which holds Crater Lake, in Oregon, though the two are of entirely different types, Crater Lake representing the so-called calderas, formed by collapse, and Aniakchak being the result of explosion.

PROFESSIONAL PAPER 134. Upper Cretaceous and Tertiary formations of the western part of the San Juan Basin, Colo. and N. Mex., by J. B. Reeside, jr., and Flora of the Animas formation, by F. H. Knowlton, 121 pp., 19 pls. (incl. 1 map), 5 figs.

The geology and paleontology of the San Juan Basin have been under study for many years, but much of the early work was of a strictly reconnaissance type and left many problems to be solved by later and more detailed observation. This paper summarizes the earlier knowledge of the stratigraphy and presents some of the results of later work that contribute to its better interpretation.

PROFESSIONAL PAPER 135. The composition of the river and lake waters of the United States, by F. W. Clarke. 203 pp.

A compilation of several thousand analyses, representing about 650 different rivers and lakes, collected during a long systematic investigation. Some of the tables are accompanied by attempts to discover relations between the waters and their lithologic origin.

BULLETIN 750-C. Observations on the rich silver ores of Aspen, Colo., by E. S. Bastin. 24 pp., 1 pl., 10 figs.

A paper giving the results of microscopic study of samples of the Aspen silver ores, which throw some light on their origin.

BULLETIN 750-D. New and known minerals from the Utah-Colorado carnotite region, by F. L. Hess. 18 pp., 8 pls.

Brief description of the new minerals vanoxite and rauvite, also of meta-torbernite, sippeite, and tyuyamunite.

BULLETIN 750-E. Deposits of magnesial alum near Fallon, Nev., by D. F. Hewett. 10 pp., 2 figs.

Describes recently discovered deposits that are of interest because the application of alum to certain hard soils in arid regions makes them more pervious to water and therefore susceptible of cultivation. Such soils exist near Fallon, and the alum can find a local market.

BULLETIN 750-F. Molybdenite in the Rocky Bar district, Idaho, by F. C. Schrader. 15 pp., 1 pl., 3 figs.

Describes several deposits of molybdenite, the chief ore mineral of the metal molybdenum, which is used in hardening steel.

BULLETIN 750-G. Bauxite in northeastern Mississippi, by E. F. Burchard. 55 pp., 3 figs.

Deposits of bauxite, a source of metallic aluminum, were recently discovered in northeastern Mississippi by a nontechnical but keen prospector who was guided in his search by a description given in a geologic report in 1861, more than a quarter of a century before bauxite was known to occur in the United States. Further prospecting has shown that the deposits contain about 1,500,000 tons. The bulk of the material is of low grade, but there are many uses for such ore. This report describes the geology of the deposits and contains many analyses, also a bibliography.

BULLETIN 750. Contributions to economic geology (short papers and preliminary reports), 1923-24, Part I, Metals and nonmetals except fuels; F. L. Ransome, G. F. Loughlin, G. R. Mansfield, and E. F. Burchard, geologists in charge. v, 148 pp., 12 pls., 30 figs.

Contains papers on rare minerals in Utah, Colorado, and Idaho, silver ores in Colorado and Utah, magnesial alum in Nevada, and bauxite in Mississippi, previously published as advance chapters.

BULLETIN 751-C. Geology and possible oil and gas resources of the faulted area south of the Bearpaw Mountains, Mont., by Frank Reeves. 48 pp., 5 pls. (incl. 2 maps), 5 figs.

Based on an investigation of the oil and gas resources of the area mentioned and a study of the faults, which are unique in extent and character. Contains maps and sections showing structure and a preliminary account of the faults. Concludes that the conditions are theoretically favorable for the occurrence of commercial accumulations and justify further test wells.

BULLETIN 751-D. Geologic structure of San Juan Canyon and adjacent country, Utah, by H. D. Miser. 45 pp., 6 pls. (incl. 1 map), 1 fig.

San Juan Canyon, in southeastern Utah, a winding chasm with close precipitous walls as much as half a mile high, is continuous for 133 miles except for short stretches of open country. This report gives data obtained during an exploration that had as its primary object the mapping and study of the river in connection with proposed power and storage projects along the San Juan and the Colorado. The San Juan oil field lies within the region studied.

BULLETIN 751-E. The Scobey lignite field, Valley, Daniels, and Sheridan counties, Mont., by A. J. Collier. 80 pp., 9 pls. (incl. 1 map), 3 figs.

Gives information concerning a lignite field covering over 2,000 square miles in the extreme northeast corner of Montana. To obtain data for classification of the public land with regard to lignite, the area was examined in considerable detail, and the information presented in the paper is correspondingly complete.

BULLETIN 751-F. The Ekalaka lignite field, southeastern Montana, by C. M. Bauer. 41 pp., 5 pls. (incl. 2 maps), 1 fig.

Presents the results of a geologic examination of an area of more than 3,000 square miles in southeastern Montana, in which lignite is the chief mineral resource.

BULLETIN 751-G. Geology and oil and gas prospects of part of Moffat County, Colo., and southern Sweetwater County, Wyo., by J. D. Sears. 57 pp., 3 pls. (incl. 1 map), 3 figs.

Covers an area of 2,800 square miles in the northwest corner of Colorado and the adjacent part of Wyoming, in which the existence of oil-saturated rocks and of well-developed domes and anticlines has drawn attention to the possibility of finding petroleum and natural gas in commercial quantities there.

BULLETIN 751. Contributions to economic geology (short papers and preliminary reports), 1923-24, Part II, Mineral fuels; K. C. Heald and W. T. Thom, jr., geologists in charge. vi, 326 pp., 37 pls. (incl. 9 maps), 25 figs.

Contains seven papers previously published in separate form, on oil or gas in Colorado, Wyoming, Oklahoma, Montana, and Utah and lignite in Montana.

BULLETIN 753. Geology and oil resources of a part of Los Angeles and Ventura counties, Calif., by W. S. W. Kew. 210 pp., 17 pls. (incl. 5 maps), 7 figs.

In the region described in this report the first petroleum used by white men in California was obtained by the padres of the early missions, who gathered tar from natural seepages. The pioneer attempt at refining was made in 1856, and from 1860 to 1900 there was considerable activity in exploiting the oil resources of this region. Within the last few years the advancing price of crude oil has stimulated a renewal of interest in the region, and some new territory has been developed. This latest work has been done according to modern geologic principles, in marked contrast to the haphazard location of wells in the early days. A geologic report on part of this area was published in 1907, but since that time the knowledge of California geology has greatly advanced, and the present report includes results of a more recent survey.

BULLETIN 755-D. The Cold Bay-Chignik district, Alaska; by W. R. Smith and A. A. Baker. 72 pp., 5 maps, 1 fig.

Describes the geology and geography of an area on the southeast side of the Alaska Peninsula, west of Kodiak Island, gives notes on petroleum seepages and coal beds, and includes analyses of samples of coal.

BULLETIN 755. Mineral resources of Alaska: report on progress of investigations in 1922, by A. H. Brooks and others. 239 pp., 12 pls. (maps), 2 figs.

The annual summary of the work of the Geological Survey in Alaska. Contains a sketch of the mining industry, papers on the Chitina Valley, the region traversed by the Alaska Railroad, and the Cold-Bay-Chignik district, and a list of recent Survey publications on Alaska.

BULLETIN 756. Oil and gas fields of the Lost Soldier-Ferris district, Wyo., by A. E. Fath and G. F. Moulton. 63 pp., 8 pls. (incl. 2 maps), 2 figs., 1 insert.

Most of the land in the Lost Soldier-Ferris district forms a part of the Federal domain, and this report presents the geologic findings of an examination made to obtain data for classifying the public land. The district contains six oil and gas fields. The report contains structure maps and a large correlation table for the principal Wyoming fields.

BULLETIN 757. Geology and coal resources of the Axial and Monument Butte quadrangles, Moffat County, Colo., by E. T. Hancock. vi, 134 pp., 19 pls. (incl. 1 map), 6 figs.

Describes an area of about 450 square miles that includes parts of two great coal-bearing basins—the Green River Basin on the north and the Uinta Basin on the south. The completion of the Moffat tunnel will doubtless lead to extensive exploitation of the great reserves of coal in this area. The coal resources comprise subbituminous and bituminous coal, most of which lies fairly near the surface—at depths of 900 to 1,200 feet.

BULLETIN 758. Bibliography of North American geology for 1921-22, by J. M. Nickles. 275 pp.

One of the regular series of bibliographies prepared in the Survey library. An essential tool for every worker in geology.

BULLETIN 759. Geology of the Bristow quadrangle, Creek County, Okla., with reference to petroleum and natural gas, by A. E. Fath. iv, 63 pp., 13 pls., 3 figs.

The Bristow quadrangle lies between two of Oklahoma's greatest oil fields, the Cushing and Glenn. A geologic investigation of this area disclosed two promising anticlines, and before the investigation was completed a preliminary report describing these anticlines was issued. Development work based on this report proved that the anticlines controlled good oil and gas pools, and the investigation was continued. This paper gives the results of the whole work, with additional information based on brief subsequent visits. It includes suggestions as to drilling in untested parts of the area.

BULLETIN 760-B. The physical features of central Massachusetts, by W. C. Alden. 99 pp., 17 pls. (incl. 3 maps), 11 figs.

Describes the surface features of an upland area of about 1,800 square miles. The rocks now exposed in this area must have been formed at great depths, and therefore their exposure is due to the removal of great thicknesses of overlying rock by weathering and stream erosion. This paper sets forth the later geologic history of the "worn-down mountain region" thus produced and gives special attention to the events of Quaternary time, when the region was covered with a vast sheet of ice. The clear traces of its presence left by the glacier are described and pictured, and the paper contains a topographic map showing the location of the glacial features.

BULLETIN 760-C. Erosion by solution and fill, by W. T. Lee. 17 pp., 8 pls., 5 figs.

A discussion of the removal of material by solution and its redeposition elsewhere that are common processes in a limestone region, with special reference to Carlsbad Cavern, N. Mex., an unusually large cavity, which because of its size and the splendor of its onyx decorations has been made a national monument. Contains a map and profiles of the cavern region and illustrations of some of the most striking features in the cavern.

BULLETIN 760-D. Pedestal rocks in stream channels, by Kirk Bryan. 14 pp. (incl. title-page, contents, and index to volume), 2 pls.

Describes certain "mushroom" rocks that resemble those formed by wind scour but are due to differential stream erosion.

BULLETIN 761. Molybdenum deposits, a short review, by F. L. Hess. 39 pp., 10 pls., 4 figs.

Gives an epitome of the world's larger molybdenum resources, in order that those who are interested in mining molybdenum may appraise the competition they must meet and that those who are interested in the use of molybdenum may estimate the probable supply. The largest known deposits of molybdenite, the chief mineral of molybdenum, are in the United States.

BULLETIN 762. Geology and ore deposits of the Rochester district, Nev., by Adolph Knopf. 88 pp., 4 pls. (incl. 2 maps), 5 figs.

The Rochester silver-mining district ranks second among the silver districts of western Nevada, though far below Tonopah. The ore deposits owe their value to enrichment by descending surface water and consequently are not likely to extend to great depth. This fact has set a limit to the ground in which it is worth while to search for ore. The deposits show an unusual mineralogic association, including several rare minerals. This report, besides describing the district, throws considerable new light on the geology of the Humboldt Range.

BULLETIN 763. Geology and ore deposits of the Aravalpa and Stanley mining districts, Graham County, Ariz., by C. P. Ross. vi, 120 pp., 13 pls., 8 figs.

The presence of deposits of silver, copper, and lead in the Aravalpa-Stanley region has been known for 50 years, but development has been hindered by inaccessibility and lack of capital. Improvement in conditions governing the mining industry in general will probably stimulate development in this region, and its future may be regarded optimistically. This report sets forth the geology of the region and describes the ore deposits and the mines and prospects.

- BULLETIN 764.** Phosphate deposits in the Wind River Mountains, near Lander, Wyo., by D. D. Condit. 45 pp., 3 pls. (incl. 1 map), 1 fig.

Beds of high-grade phosphate rock underlie many thousands of square miles in Montana, Idaho, Wyoming, and Utah. The rock has been mined at a few places, but the output has been only a small fraction of that of the United States. The gradual depletion of fertility in the wheat-producing areas is bringing closer the time when much of this land must be artificially renewed. This report describes some phosphate deposits in west-central Wyoming that lie within convenient reach of the wheat belt and are close to a main-line railway.

- BULLETIN 765.** Geology of the region around Lead, S. Dak., and its bearing on the Homestake ore body, by Sidney Paige. 62 pp., 11 pls. (incl. 2 maps), 19 figs.

Gives results of a study of the nature and origin of the ore body in the Homestake mine, perhaps the greatest gold mine in the world. The work was part of a more general study of the geology and mineral resources of the Black Hills. The report shows how the conclusions reached can be applied directly in the development of the ore body and the search for new ore bodies and indicates features that should be subject to further study.

- BULLETINS 766-A to 766-BBB.** Spirit leveling in California, 1896-1923; C. H. Birdseye, chief topographic engineer.

The results of leveling in California were published in separate leaflets, each covering one degree of latitude and longitude. Chapter A contains a general statement in regard to the work and an index map of California, and chapter BBB gives a table of secondary elevations.

- BULLETIN 769.** The geologic time classification of the United States Geological Survey compared with other classifications, accompanied by the original definitions of era, period, and epoch terms, a compilation, by M. G. Willmarth. vi, 138 pp., 1 pl.

The increased emphasis given by many geologists to the results of diastrophism as the basis of stratigraphic classification has led to the proposal of several major changes in classification, but the geologists who have proposed changes have differed among themselves, so that several classifications are now current, both in the United States and in Europe. This bulletin contains a chart in which a number of these classifications are compared, quotes the original definitions of the major terms, and indicates the changes they have undergone.

- BULLETIN 770.** The data of geochemistry (fifth edition), by F. W. Clarke. 841 pp.

All rocks are subject to the action of various agencies which bring about chemical changes. Every such change implies a disturbance of chemical equilibrium and eventually a reestablishment of the maximum possible stability under the new conditions. To determine what changes are possible and how and when they occur, to observe the phenomena that attend them, and to note their final results are the functions of the geochemist. The literature on geochemistry is vast but widely scattered and in part difficult of access. To bring some of the data together, to formulate a few of the problems, and to present certain general conclusions in their modern form are the purposes of this memoir. The present volume is the fifth edition of this work, of which the first edition was published in 1908 and the fourth in 1920. The text has been revised and enlarged for this edition. The book has an exceptionally complete index and is of great value to all students of geology and chemistry.

- BULLETIN 772.** A reconnaissance of the Point Barrow region, Alaska, by Sidney Paige, W. T. Foran, and James Gilluly. v. 33 pp., 9 pls. (incl. 1 map), 4 figs.

Report on an expedition made in 1923 as a part of the plan to search Naval Petroleum Reserve No. 4 for evidence of petroleum. The project originated with the Department of the Navy, which supplied the funds for carrying it out. The expedition surveyed two large oil seepages and learned much about the geology of a belt extending from the coast 50 to 200 miles inland. The information obtained showed that further geologic exploration of the region was fully justified, and a second expedition, a report on which is now in preparation, was made in 1924, and a third in 1925. The expedition of 1923 also discovered an extensive coal field. It threw much light on the geology and physical features of more than 10,000 square miles, or nearly a third of the reserve, and obtained the information needed to plan the subsequent surveys efficiently and economically.

- BULLETIN 773-A.** Alaska's mineral resources and production, 1923, by A. H. Brooks; An early Tertiary placer deposit in the Yentna district, by S. R. Capps; Administrative report, by A. H. Brooks, 89 pp., 2 figs.

The twentieth annual summary of geologic work in Alaska shows that although the days of quick returns from bonanza placer mining are passed, the Alaskan mining industry is gradually being built up on a stable basis and has been especially stimulated by the completion of the Alaska Railroad and the consequent lowering of mining cost. From 1880 to the end of 1923 Alaska's mineral production amounted to \$517,627,000, of which about \$341,000,000 was in gold. The value in 1923 was \$20,000,000. This pamphlet contains also a short report on a placer deposit where the conditions indicate a large area favorable for prospecting.

BULLETIN 773-B. Mineral investigations in southeastern Alaska, by A. F. Buddington. 73 pp., 2 pls. (maps), 5 figs.

Describes ore deposits in the Hyder district, adjacent to the British Columbia boundary; nickel-copper deposits on some of the southeastern Alaska islands; gold deposits in the Sitka, Juneau, and Ketchikan districts; copper prospects in the Juneau district; and magnetite, silver, barite, and zinc at other localities.

BULLETIN 773-C. The occurrence of copper on Prince William Sound, Alaska, by F. H. Moffit. 20 pp.

Copper deposits on Prince William Sound were staked as early as 1897, and interest grew rapidly until 1907, but unfavorable financial conditions have since reduced prospecting almost to the vanishing point. This paper sets forth the geologic relations of the deposits and includes some new material obtained from a field study in 1923. The ore bodies are mainly of low grade, and the surface exposures are a fair indication of what may be expected below.

BULLETIN 780-A. The Melrose phosphate field, Mont., by R. W. Richards and J. T. Pardee. 36 pp., 2 pls. (maps), 2 figs.

Describes the geology and phosphate resources of two areas in southwestern Montana, near the Oregon Short Line Railroad. The deposits are not as good as the beds in many parts of the Idaho fields, though they probably have some advantage over the Idaho deposits in that they are close to a potential supply of cheap acid—the smelters at Anaconda, Butte, and Great Falls.

WATER-SUPPLY PAPER 509. Surface water supply of the United States, 1919-20, Part IX, Colorado River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, A. B. Purton, and H. D. McGlashan, district engineers. v, 269 pp., 2 pls.

WATER-SUPPLY PAPER 513. Surface water supply of the United States, 1919-20, Part XII, North Pacific slope drainage basins, B. Snake River basin; N. C. Grover, chief hydraulic engineer; G. C. Baldwin, G. L. Parker, C. G. Paulsen, A. B. Purton, and F. F. Henshaw, district engineers. 384 pp., 2 pls.

WATER-SUPPLY PAPER 514. Surface water supply of the United States, 1919-20, Part XII, North Pacific slope drainage basins, C. Lower Columbia River basin and Pacific slope drainage basins in Oregon; N. C. Grover, chief hydraulic engineer; F. F. Henshaw and G. L. Parker, district engineers. 210 pp., 2 pls.

Three of the regular reports on stream gaging, covering the two years ended September 30, 1920.

WATER-SUPPLY PAPER 516. Surface water supply of Hawaii, July 1, 1919, to June 30, 1920; N. C. Grover, chief hydraulic engineer; J. E. Stewart, district engineer. 165 pp.

Gives the results of measurements of the flow of streams in the Hawaiian Islands during the period indicated. Most of the work was done in cooperation with the Territorial Government, the Hawaiian Department of the United States Army, the city and county of Honolulu, and private persons and corporations.

WATER-SUPPLY PAPER 517. Water powers of the Great Salt Lake basin, by R. R. Woolley, with an introduction by N. C. Grover. 286 pp., 13 pls. (incl. 7 maps), 8 figs.

Contains a large amount of detailed information bearing on the power resources of the Great Salt Lake basin, which covers about 27,000 square miles in Utah, Nevada, Idaho, and Wyoming. The capacity of the 50 hydroelectric plants installed by the end of 1923 was over 225,000 horsepower. The maximum estimate of additional potential power at 65 sites investigated is 115,000 horsepower. The market for power is indicated by the statement that in or near the basin raw materials are easily accessible for extensive steel manufacture, for a colossal chemical industry, and for utilizing the by-products from a great coke industry.

WATER-SUPPLY PAPER 518. Ground water in Musselshell and Golden Valley counties, Mont., by A. J. Ellis and O. E. Meinzer. 98 pp., 5 pls. (incl. 1 map), 11 figs.

A report giving the results of an investigation made in response to a general demand for more water in a semiarid part of central Montana. Describes the rock formations and their capacity to hold and carry water, the artesian conditions, the quality of the water, the utilization of rain and surface waters, and the ground-water conditions by townships. Prepared in cooperation with the State engineer, the Department of Chemistry of the State College, and the Water Laboratory of the Montana Board of Health.

WATER-SUPPLY PAPER 519. Ground water in Santa Clara Valley, Calif., by W. O. Clark. 217 pp., 19 pls. (incl. 15 maps), 20 figs.

Report on an investigation made in cooperation with the California State Department of Engineering to estimate the quantity of ground water available annually in different parts of Santa Clara Valley and to determine how the supply can be best conserved and utilized. This valley is a region of intensive agricultural development and is one of the richest valleys in California. The famous Santa Clara prunes form the leading crop, and apricots are also grown in large quantities. Both these crops are almost wholly dependent on ground water for irrigation.

WATER-SUPPLY PAPER 520-C. Power resources of Snake River between Huntington, Oreg., and Lewiston, Idaho, by W. G. Hoyt. 27 pp.

Sets forth the potential power in the greater part of the 200-mile stretch of Snake River that forms a portion of the boundary between Idaho and Oregon. In a part of this stretch the canyon of the Snake is deeper and narrower than the Grand Canyon at El Tovar. Estimates of power are given for sixteen undeveloped sites, some of which will no doubt be utilized in response to the demand for power arising from the increasing industrial development of the Northwest.

WATER-SUPPLY PAPER 520-D. Base exchange in ground water by silicates as illustrated in Montana, by B. C. Renick. 22 pp., 3 pls., 1 fig.

Studies of ground water in an area in east-central Montana show that the water near the surface is relatively high in calcium and magnesium, which with increasing depth are exchanged for sodium (and potassium?), the result being a natural softening of the water. This paper considers the processes involved, which appear to differ from those that produce ore enrichment or deep brines.

WATER-SUPPLY PAPER 520-E. The artesian-water supply of the Dakota sandstone in North Dakota, with special reference to the Edgeley quadrangle, by O. E. Meinzer and H. A. Hard. 25 pp., 2 pls., 2 figs.

The Dakota sandstone, with the overlying impermeable shale, forms the most remarkable artesian basin in the United States with respect to its great extent and the tremendous pressure under which the water was originally held. The first well to reach this sandstone was put down in 1882, and it is estimated that by 1923 there were about 18,000 artesian wells tapping this reservoir in North and South Dakota. The original pressure has of course greatly declined, and many of the wells have ceased to flow. This paper is based on an investigation made in cooperation with the North Dakota Geological Survey covering about 230 artesian wells in the southeastern part of the State. It sets forth a program for checking the rate of decline and conserving the existing flowing wells.

WATER-SUPPLY PAPER 520-F. Temperature of water available for industrial use in the United States, by W. D. Collins. 10 pp., 4 pls.

The importance of water supply as a limiting factor in industrial development may be determined not only by its quantity or quality but by its temperature. This paper shows the mean monthly temperature of surface water and of air at or near 20 cities for periods ranging from one year to twelve years.

WATER-SUPPLY PAPER 520-G. Some floods in the Rocky Mountain region, by Robert Follansbee and P. V. Hodges. 40 pp. (incl. title-page, contents, list of illustrations, and index to volume), 1 pl. (map), 3 figs.

Describes the principal floods that occurred in Wyoming and Colorado in 1923 and gives the results of a study of the areas in Colorado most subject to the so-called cloudburst floods, which are especially disastrous to railroads and highways.

WATER-SUPPLY PAPER 521. Surface water supply of the United States, 1921, Part I, North Atlantic slope drainage basins; N. C. Grover, chief hydraulic engineer; C. H. Pierce, C. C. Covert, O. W. Hartwell, A. H. Horton, and G. C. Stevens, district engineers. vi, 294 pp., 2 pls.

WATER-SUPPLY PAPER 523. Surface water supply of the United States, 1921, Part III, Ohio River basin; N. C. Grover, chief hydraulic engineer; O. W. Hartwell, A. H. Horton, Lasley Lee, H. E. Grosbach, W. E. Hall, and W. R. King, district engineers. vi, 316 pp., 2 pls.

WATER-SUPPLY PAPER 525. Surface water supply of the United States, 1921, Part V, Hudson Bay and upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. A. Lamb, S. B. Soulé, H. E. Grosbach, and E. D. Burchard, district engineers. 197 pp., 2 pls.

WATER-SUPPLY PAPER 531. Surface water supply of the United States, 1921, Part XI, Pacific slope basins in California; N. C. Grover, chief hydraulic engineer; H. D. McGlashan and F. F. Henshaw, district engineers. vii, 304 pp., 2 pls.

WATER-SUPPLY PAPER 532. Surface water supply of the United States, 1921, Part XII, North Pacific slope drainage basins, A, Pacific basins in Washington and upper Columbia River basins; N. C. Grover, chief hydraulic engineer, G. L. Parker and W. A. Lamb, district engineers. 228 pp., 2 pls.

Five of the series of reports on stream gaging during the year ending September 30, 1921.

WATER-SUPPLY PAPER 535. Surface water supply of Hawaii, July 1, 1920, to June 30, 1921; N. C. Grover, chief hydraulic engineer; J. E. Stewart, district engineer.

The annual report on stream gaging in the Hawaiian Islands. Gives records obtained at about 70 stations on the four principal islands of the group.

WATER-SUPPLY PAPER 536. Surface water supply of the New-Kanawha River basin, W. Va.-Va.-N. C.; N. C. Grover, chief hydraulic engineer; A. H. Horton and G. C. Stevens, district engineers. iv, 282 pp., 2 pls.

A compilation of records of stream flow obtained at 32 gaging stations in the basin of New-Kanawha River since 1908.

WATER-SUPPLY PAPER 537. A study of coastal ground water, with special reference to Connecticut, by J. S. Brown. viii, 101 pp., 7 pls., 20 figs.

The intensive human activity concentrated along the seacoasts of the United States requires a great number of large and small water supplies, but at many places on the coast the proximity of salt water makes it difficult to obtain supplies of good quality. This paper was prepared to meet a demand for information as to the prospects of obtaining fresh water from wells sunk near the sea. It is based largely on field work on the coasts of Connecticut and Florida but contains data from many sources on coastal ground water in the United States and an annotated bibliography that includes the valuable but relatively inaccessible foreign literature.

WATER-SUPPLY PAPER 538. The San Juan Canyon, southeastern Utah, a geographic and hydrographic reconnaissance, by H. D. Miser. 86 pp., 22 pls. (incl. 1 map), 3 figs.

Report of the geographic and hydrographic phases of an exploration made in connection with proposed power and storage projects along the San Juan and the Colorado. The region trenched by the canyon, whose walls are in places half a mile high, is rough, arid, and difficult of access and has only a few score inhabitants. This paper gives a large amount of interesting information about the region, illustrated by numerous views, and a vivid description of the difficulties encountered in the reconnaissance.

WATER-SUPPLY PAPER 539. Geology and ground-water resources of Townsend Valley, Mont., by J. T. Pardee. iv, 61 pp., 2 pls., 7 figs.

Describes an area of about 600 square miles near Helena, Mont., in which farming and stock raising are the principal industries. Based on an examination made to determine whether flowing wells could be obtained on the unirrigated bench lands at the sides of the valley, where dry farming has been attempted in recent years with varying success. Concludes that although conditions favorable for artesian flow may exist in small areas, they are not general. Ground water is found in the bench lands at depths ranging from 100 to 300 feet.

WATER-SUPPLY PAPER 541. Surface water supply of the United States, 1922, Part I, North Atlantic slope drainage basins; N. C. Grover, chief hydraulic engineer; C. H. Pierce, C. C. Covert, A. W. Harrington, O. W. Hartwell, and A. H. Horton, district engineers. 264 pp., 2 pls.

One of the annual reports on stream gaging, giving results of measurements during the year ending September 30, 1922.

WATER-SUPPLY PAPER 560-A. Water power and irrigation in the Madison River basin, Mont., by J. F. Deeds and W. N. White. 32 pp., 2 figs.

Describes the basin of Madison River, at whose headwaters are the famous geysers of Yellowstone National Park. This basin yields annually more than 1,400,000 acre-feet of water that can be used for the development of hydroelectric power and for irrigation. Development within the park is prohibited by law, but the power resources of the rest of the basin are estimated at 154,000 horsepower, of which 18,000 horsepower has already been developed. About 2.1 per cent of the basin is irrigated, and about as much more is included in irrigation projects.

WATER-SUPPLY PAPER 560-B. Chemical character of ground waters of the northern Great Plains, by H. B. Riffenburg. 24 pp., 4 figs.

Covers an area extending from the eastern border of the Dakotas to the Rocky Mountain foothills and from the Canadian boundary into Wyoming and South Dakota. Based on a study of more than 1,000 published and unpublished analyses of ground water in this area.

WATER-SUPPLY PAPER 560-C. Index of analyses of natural waters in the United States, by W. D. Collins and C. S. Howard. 35 pp.

An annotated list of more than 350 published collections of analyses of natural waters, including general reports and reports relating to particular States.

MINERAL RESOURCES OF THE UNITED STATES, 1922. 3 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1923. 56 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1924. 2 advance chapters.

GEOLOGIC FOLIO 219. Central Black Hills, S. Dak., by N. H. Darton and Sidney Paige. 35 folio pages of text, 7 maps, 30 pls., 43 figs.

Description of four quadrangles (Deadwood, Rapid, Harney Peak, and Hermosa), covering an area of about 3,400 square miles in southwestern South Dakota, comprising much of the Black Hills uplift and, along its eastern margin, a wide belt of plains. The region consists largely of high forested ridges that are not well adapted to agriculture, and the chief industry is mining. The famous Homestake mine is at Lead, and other mines at Deadwood. The geology of this region is complicated and interesting. The central core of the Black Hills uplift consists of Algonkian rocks, and around it is upturned a nearly complete sequence of sedimentary formations ranging in age from Upper Cambrian to latest Cretaceous. Wind Cave, which is included in a national park, consists of extensive passages and chambers in the Pabaspala limestone, a formation of Mississippian age, in which also are Jewell Cave, a national monument, and several smaller caverns. The principal metalliferous resources of this region are the gold ores, though the gold that made the Black Hills famous in the early days was obtained from placers at Deadwood. The region contains also ores of lead-silver, tungsten, tin, and copper, together with deposits of mica, lithium, and tantalum and other minor mineral resources. In the eastern part artesian water is obtained from the Dakota sandstone.

TOPOGRAPHIC AND OTHER MAPS as follows. The maps marked with an asterisk (*) were published also with green overprint showing woodland.

Alaska

ALASKA. Scale, 1 inch=approximately 80 miles. (Map A.)

Revised edition of a base map of Alaska first published in 1909. This map does not show contours. The principal changes in the map are in the region of Katmai National Monument, in the region of Mount McKinley National Park, and on the Arctic slope, where considerable exploratory work has been done recently.

ALASKA RAILROAD—MATANUSKA COAL FIELD TO YANERT FORK: Latitude, 61° 30' to 63° 50'; longitude, 146° 50' to 151° 10'. Scale, 1 inch=4 miles; contour interval, 200 feet.

Topographic map of the area near the middle third of the Alaska Railroad, including the valleys of upper Matanuska River and upper Susitna River and a large part of the Mount McKinley National Park, with the peak of Mount McKinley, the highest in North America, which towers 20,300 feet above sea level.

ALASKA RAILROAD—YANERT FORK TO FAIRBANKS: Latitude, 63° 40' to 65° 35'; longitude, 146° 40' to 151° 20'. Scale, 1 inch=4 miles; contour interval, 200 feet.

Topographic map of the area near the northern third of the Alaska Railroad, including the Fairbanks gold mining district, near the end of the railroad; the Tolovana, Kantishna, Bonfield, and Hot Springs district, in the Tanana basin; and the Rampart district, in the Yukon basin.

Arizona

CASA GRANDE: Latitude, 32° 45' to 33°; longitude, 111° 45' to 112°. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in Pinal County, including on its eastern margin the town of Casa Grande, the point of departure for the famous Casa Grande ruin, about 15 miles northeast. The surface is mainly a plain that slopes from 1,470 to 1,225 feet above sea level. The highest point in the area is a summit of Double Peak, in the extreme southwest corner, which rises 2,283 feet above sea level. The plain is well adapted to farming, lacking only an adequate supply of water. At present it receives a small amount from Gila River by the Casa Grande-Florence canal.

SIGNAL PEAK: Latitude, 32° 45' to 33°; longitude, 111° 30' to 111° 45'. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in Pinal County, 50 miles northwest of Tucson. In the northeast corner of the area is the Casa Grande ruin, one of the best-preserved aboriginal pueblos of the Southwest, which lies within the Casa Grande National Monument. Above the monotonous plain rise two groups of mountains—the Casa Grande Mountains, in the southwestern part of the area, and a spur of the Sacaton Mountains, in the northern part. The highest peak shown, which is in the Casa Grande Mountains, stands 2,323 feet above sea level. The plain ranges in height from 1,575 to 1,370 feet. Not many years ago this plain was an uninhabited desert, but the Casa Grande-Florence canal, shown on the map, has now made it available for complete irrigation, and it is therefore still sparsely inhabited.

Arizona-Nevada

COLORADO RIVER: Plan and profile of Colorado River from Lees Ferry, Ariz., to Black Canyon, Ariz.-Nev., and Virgin River, Nev. Scale, 2 inches=1 mile; contour interval on land, 50 feet, on river surface, 5 feet; vertical scale of profiles, 1 inch=20 feet. 21 sheets (14 plans; 7 profiles).

Maps of that part of Colorado River that includes the Grand Canyon and a considerable stretch below it and of the lower part of Virgin River. The maps were made from surveys carried continuously along the Colorado for a distance of 356 miles and up Virgin River for 37 miles above its mouth. They show every stretch of still water and every rapid in the parts of the rivers surveyed and indicate by contour lines the slope of the cliffs on both sides for a height of 500 to 2,000 feet above the river. The surveys were made to determine the power available from these streams, and the maps show possible dam sites.

California

COMPTON: Latitude, 33° 48' to 33° 54'; longitude, 118° 12' to 118° 18'. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of an area just north of Long Beach, including the newly developed Dominguez oil field. The Dominguez Hills rise to a height of 145 feet above the surrounding plain, most of which stands less than 50 feet above sea level.

DINUBA: Latitude, 36° 30' to 37°; longitude, 119° to 119° 30'. Scale, 1 inch=2 miles; contour interval, 100 feet.

Map of parts of Fresno and Tulare counties, on the west slope of the Sierra Nevada, in the eastern part of San Joaquin Valley. The surface slopes from 8,140 to 300 feet above sea level, being broken by many ridges and knobs that rise from 500 to 2,000 feet above the adjacent valleys. Kings River crosses the area, but the great canyon for which this river is noted lies in the next quadrangle to the east. The valley portion of the area is thickly settled, as it is well irrigated by water from Kings River.

INGLEWOOD: Latitude, 33° 54' to 34°; longitude, 118° 18' to 118° 24'. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of a small area that includes the southwestern part of Los Angeles and the town of Inglewood. The area is crossed from northwest to southeast by a range of hills, which is highest just north of Inglewood. Northeast of these hills lies a plain at an altitude of about 130 feet, upon which Los Angeles has been built, and southeast of the hills lies a lower plain, 50 to 75 feet in altitude, on which is much of the town of Inglewood. The southwest corner of the area includes some of the sand dunes that form a characteristic feature of the coast a few miles farther west.

JAMESAN: Latitude, 36° 37' 30'' to 36° 45'; longitude, 120° 07' 30'' to 120° 15'. Scale, 1 inch=½ mile; contour interval, 5 feet.

Map of a small area in Fresno County, about 19 miles west of Fresno, in the bottom of San Joaquin Valley. Kings River Slough, the uppermost tributary of the San Joaquin, flows across its southwest corner. From this slough the surface rises gradually toward the northeast, from 165 to 205 feet above sea level. The most prominent features on the map are the great canals and ditches by which the water from the Sierra Nevada is carried to different parts of the valley where it is utilized for growing crops.

POINT SUR: Latitude, 36° 15' to 36° 30'; longitude, 121° 45' to 122°. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Monterey County, on the coast. First edition published as a photolithograph in 1918. This edition shows new data including under-water contours and revised national-forest information.

TRANQUILITY: Latitude, 36° 37' 30'' to 36° 45'; longitude, 120° 15' to 120° 22' 30''. Scale, 1 inch=½ mile; contour interval, 5 feet.

Map of a small area in Fresno County that is crossed by Kings River Slough, the outlet of Lake Tulare. From this drainage channel the surface rises gently both northeastward and southwestward, the range in altitude being about 30 feet. The lowest point in the area is about 160 feet above sea level.

VENICE: Latitude, 33° 54' to 34°; longitude, 118° 24' to 118° 30'. Scale, 1 inch=2,000 feet; contour interval on land, 5 feet; on sea bottom, 5, 10, and 25 feet.

Map of an area on Santa Monica Bay, extending from Santa Monica and Venice to Manhattan Beach—the seaside playground of Los Angeles. Near Venice the shore consists of a low barrier beach built across the mouth of Ballona Creek valley. Southeast of Playa del Rey the surface is a barren wilderness of sand dunes, except in El Segundo, where a town has been built around a large oil refinery. In this part of the area the shore is bordered by a great ridge of sand 175 feet high, which is separated from the dune area to the east by a parallel depression, 65 to 125 feet above sea level. This ridge and depression are supposed to have been produced by an earthquake rift. The abrupt ending of the sand dunes at the southern edge of the valley of Ballona Creek may also be the result of earth movement.

WATTS: Latitude, 33° 54' to 34°; longitude, 118° 12' to 118° 18'. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of an area in Los Angeles County, including the southern part of Los Angeles and the suburban towns of Watts, Vernon, Huntington Park, South Gate, Lynwood, Compton, and Athens. The surface is essentially a plain that slopes from about 190 to 70 feet above sea level. The southwestern part is crossed by a low ridge that reaches an altitude of 220 feet west of Athens, but from the crest of this ridge to the southwest corner of the area the surface drops to an altitude of 50 feet.

Colorado

DENVER MOUNTAIN PARKS: Latitude, 39° 30' to 39° 45'; longitude, 105° 10' to 105° 40'. Scale, 1 inch=1 mile; contour interval, 100 feet.

Map of an area in Jefferson, Clear Creek, and Park counties, extending from Golden and Morrison to Mount Evans and including the canyon of Clear Creek from Golden to a point a few miles above Idaho Springs, Bear Canyon from Morrison to Evergreen, and some of the famous gold-mining territory on Chicago Creek south-west of Idaho Springs. This area is a noted mountain playground of the people of Denver and is visited annually by thousands of tourists.

***ELKHEAD CREEK:** Latitude, 40° 30' to 40° 45'; longitude, 107° 15' to 107° 30'. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of parts of Moffat and Routt counties, in the drainage basin of Yampa River, which crosses the area in a rather broad valley near its southern margin. This part of the State is a dissected upland, the surface ranging in altitude from 6,200 to 9,400 feet. The area is sparsely settled. Agriculture can be carried on only by dry-land farming, except on the flood plain of the river.

***PILOT KNOB:** Latitude, 40° 30' to 40° 45'; longitude, 107° to 107° 15'. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Routt County, 25 miles west of Steamboat Springs. Yampa River flows westward not far beyond the southern margin of the area and crosses its southwest corner. The river is about 6,350 feet above sea level; the upland north of the river rises to 9,345 feet in Quaker Mountain and to 10,500 feet in Sand Mountain. The western part of the area may be considered a plateau that is bounded on the east by an irregular escarpment nearly 2,000 feet high, which, in a general way, marks the eastern margin of the Yampa coal field. East of this escarpment the surface descends to about 7,000 feet.

YAMPA RIVER: Plan and profile of Yampa River, Colo., from Green River to Morgan Gulch. Scale, 2 inches=1 mile; contour interval on land 20 feet, on river surface 5 feet; vertical scale of profiles, 1 inch=20 feet. 5 sheets (3 plans, 2 profiles).

These sheets show the course and profile of Yampa River, a tributary of Green River, from its mouth, near the Utah-Colorado boundary, eastward to Morgan Gulch.

Hawaii

ISLAND OF LANAI: Latitude, 20° 42' 30" to 20° 57' 30"; longitude, 156° 47' 30" to 157° 5'. Scale, 1 inch=1 mile; contour interval, 50 feet.

The island of Lanai lies just south of Molokai and is about 17 miles long, measured on its northwest axis, and about 12 miles wide. It rises steeply from the sea on the south and west sides to an altitude of 1,200 to 1,500 feet and on the north and east sides even more steeply to the ridge forming the backbone of the island, which at places stands nearly 3,000 feet above the sea. A more or less flat upland occupies much of the central part of the island, and here the larger settlements are situated. Among the many unusual features shown are the almost entire absence of surface streams, the long pipe lines, the almost harborless coast, the numerous benches and scarps that characterize the western slope of the ridge, and the striking topographic differences between the northeastern and southwestern parts of the island.

***ISLAND OF MOLOKAI:** Latitude, 21° to 21° 15'; longitude, 156° 40' to 157° 20'. Scale, 1 inch=1 mile; contour interval, 50 feet.

The island of Molokai is near the middle of the Hawaiian group, lying 8 miles northwest of Maui and 23 miles southeast of Oahu. It is 39 miles in length from east to west and averages a little less than 7 miles in width. The island is entirely of volcanic origin except the coral reefs that fringe its south side. It has no large active volcanoes, but Mauna Loa, which rises to a height of 1,381 feet, is believed to be an old volcanic cone, and the great semicircular ridge in the eastern part of the island is believed to be the southern half of a giant crater whose northern half was engulfed by the sea in prehistoric time. Kamakou, the most imposing point on this ridge, towers to a height of 4,970 feet above the sea. The most striking surface features of the island are the enormous gulches that have been cut by the streams in the northern slope of this ridge, some of them to a depth of as much as 3,500 feet. The north shore is precipitous, having been cut off sharply by the fault that split the volcano. The island contains the noted leper settlement of Kalau-papa.

- ***KALAPAPA:** Latitude, $19^{\circ} 15'$ to $19^{\circ} 30'$; longitude, $154^{\circ} 45'$ to 155° . Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area at the east end of the island of Hawaii. The surface features seem to be dominated by a line of small volcanic cones that trends northeastward nearly parallel to the coast, which is 3 to 4 miles distant. From this line of cones the surface descends steeply to the sea on the southeast and more gently on the north. The highest point in the area is Heiheiakulu, near its western edge, which rises 1,710 feet above sea level. The map shows several small lava flows and many fissures in the hardened lava, which run parallel with the line of cones.

- ***KILAUEA:** Latitude, $19^{\circ} 15'$ to $19^{\circ} 30'$; longitude, $155^{\circ} 15'$ to $155^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area on the southeastern slope of the island of Hawaii, including the famous crater of Kilauea and most of the Hawaii National Park. The surface rises from sea level in the southeast corner of the area to a height of more than 10,000 feet on the flank of the great peak of Mauna Loa, but the slope is not regular, as the young and immense cone of Mauna Loa has been built on the older and lower cone of Kilauea. The surface consists largely of lava that has flowed out of volcanic vents at different times. The most interesting feature shown on the map is the crater of Kilauea, which has a length of 2½ miles and a width of 2 miles. The only active vent in this great basin is the crater of Halemaumau, which has a diameter of about 1,200 feet. The old cone of Kilauea is marked by a great system of cracks that run in a southwesterly direction and near the sea by cliffs that trend in the same direction, which are supposed to mark displacements or faults.

- ***MAKUU:** Latitude, $19^{\circ} 30'$ to $19^{\circ} 45'$; longitude, $154^{\circ} 45'$ to 155° . Scale 1 inch=1 mile; contour interval, 50 feet.

Map of a small area at the extreme east end of the island of Hawaii, including Cape Kumukahi. The surface slopes uniformly from the coast to an altitude of 900 feet. Near Cape Kumukahi the regularity of the surface is broken by a few volcanic craters, the largest of them Kapoho Crater, which is about half a mile in diameter and rises about 400 feet above the sloping plain.

- ***PUNA:** Latitude, $19^{\circ} 15'$ to $19^{\circ} 30'$; longitude, 155° to $155^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of a part of the southeastern slope and shore of the island of Hawaii that lies just east of the crater of Kilauea and includes a part of the Hawaii National Park. The surface rises with considerable regularity from sea level to a height of 4,000 feet at Kilauea Iki Crater, which marks the summit of the old cone of Kilauea. On this slope are the numerous craters along a line that curves eastward from the crater and the cracks and escarpments which are the eastward continuation of similar features shown on the map of the Kilauea quadrangle.

Illinois

[See also Missouri-Illinois]

- ***ALEXIS:** Latitude, 41° to $41^{\circ} 15'$; longitude, $90^{\circ} 30'$ to $90^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Mercer and Warren counties, about 10 miles northwest of Galesburg, in the northwestern part of Illinois. The surface back from the main streams is a remarkably level plain, ranging in altitude from about 700 to 780 feet. The streams, which are parallel and flow westward to Mississippi River, have cut their valleys from 50 to 100 feet below the surface of the plain, and the side branches have to some extent dissected the plain, but it still remains a distinct physiographic feature, showing clearly that the streams have cut their valleys in comparatively recent time.

- ***DIVERNON:** Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, $89^{\circ} 30'$ to $89^{\circ} 45'$. Scale 1 inch=1 mile; contour interval, 10 feet.

Map of an area just south of Springfield, lying mainly in Sangamon County but including small parts of Macoupin, Montgomery, and Christian counties. The surface is very flat except where the streams have cut into the plain to a depth of 10 to 40 feet. It ranges in altitude from 600 to 650 feet. The map is of particular interest to teachers of physiography, for it shows the manner in which a newly made plain is gradually dissected—how the main streams and their branches grow headward until channels are formed in all parts of the area.

- ***HEERSCHER:** Latitude, 41° to $41^{\circ} 15'$; longitude 88° to $88^{\circ} 15'$. Scale 1 inch=1 mile; contour interval, 10 feet.

Map of an area in Illinois 50 miles south of Chicago, lying mainly in Kankakee County but including in its western part narrow strips of Grundy and Livingston counties. Kankakee River crosses the northeast corner, and the surface slopes toward this stream from a maximum altitude of 800 feet to about 600 feet. The river has trenched the plain to a depth of about 50 feet and is now flowing in a narrow gorge scarcely wider than its channel.

- ***KANKAKEE:** Latitude, 41° to $41^{\circ} 15'$; longitude, $87^{\circ} 45'$ to 88° . Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of parts of Kankakee and Iroquois counties. The principal town, Kankakee, is on the Egyptian Trail, a first-class automobile road, 55 miles south of Chicago. The area is drained by Kankakee River. The surface is generally flat or gently rolling and ranges in altitude from 550 to 741 feet. The level land along the river above Kankakee is the bottom of old Lake Kankakee, and the rather wide river valley is supposed to have formed the bottom of other lakes during the Great Ice Age.

- ***OREGON:** Latitude, 42° to $42^{\circ} 15'$; longitude, $89^{\circ} 15'$ to $89^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Kankakee and Iroquois counties. The principal town, Kankakee, upland that stands about 900 feet above sea level. In the upland the small streams have cut rather broad valleys that have gentle slopes, but Rock River, the principal stream in the area, has cut a valley that is but little wider than the stream itself, and the slopes that lead down to it from the upland are at places very steep. The drainage was evidently rearranged when the glaciers covered this region. Rock River was formed along the western margin of the ice, and its valley is narrow and steep because it is new.

- ***RAYMOND:** Latitude, $39^{\circ} 15'$ to $39^{\circ} 30'$; longitude, $89^{\circ} 30'$ to $89^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area about 20 miles south of Springfield, lying mainly in Montgomery County but including strips in Macoupin and Christian counties. The area is remarkable for the scarcity of streams, there being only two within its borders. The surface is a very perfect plain that lies at an altitude of about 650 feet, and because of the absence of well-marked drainage ways much of the area could not be farmed until it was drained artificially.

- ***TAYLORVILLE:** Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, $89^{\circ} 15'$ to $89^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of an area about 10 miles southeast of Springfield, lying mainly in Christian County but including a part of Sangamon County. Except for the trenches 10 to 15 feet deep cut by the larger streams, the surface is an almost unbroken plain, which ranges in altitude from 590 to 620 feet. This area illustrates the development of a drainage system on a new and very level plain. The plain was formed by the great ice sheet that passed over this part of the country, grinding off all projecting points and filling up most of the depressions in the surface. Sangamon River was the first stream to establish itself after the ice melted, and its course was probably determined by its old channel, which had not been completely obliterated. The tributary streams and their branches grew headward until the present drainage pattern was developed.

Illinois-Indiana

- ***MOMENCE:** Latitude, 41° to $41^{\circ} 15'$; longitude, $87^{\circ} 30'$ to $87^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of an area in the valley of Kankakee River, about 50 miles south of Chicago. The area lies mainly in Illinois but extends into Indiana for about 1½ miles. The northern third of the area is a rolling upland that stands about 700 feet above sea level. The remainder is a flat plain on which there are many irregular knobs and knobby ridges 10 to 30 feet high. The plain was evidently the bottom of a lake that lay in front of a glacier, and the knobs, which are arranged in more or less regular lines, indicate the position of the ice front at different stages of the retreat of the ice.

Illinois-Missouri

- ***ALTO PASS:** Latitude, $37^{\circ} 30'$ to $37^{\circ} 45'$; longitude, $89^{\circ} 15'$ to $89^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area bordering the Mississippi River bottoms, about 40 miles north of Cairo. The western third of the area includes the bottom over which Big Muddy River flows in a sinuous course to the Mississippi, which enters the area at two places on its western edge. This bottom is very flat and is in places so swampy that it can not be farmed. The most striking feature is the prominent bluff that bounds the river bottom on the east. This bluff, known as the Pine Hills, rises abruptly 800 feet above the plain, which has an altitude of 350 to 360 feet.

- ***QUINCY:** Latitude, $37^{\circ} 30'$ to $37^{\circ} 45'$; longitude, $91^{\circ} 15'$ to $91^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of the part of the Quincy quadrangle that lies east of Mississippi River, including a large part of Adams County and a small strip, about half a mile wide, of Pike County, Ill. The most interesting feature shown on the map is Mississippi River, whose tortuous channel, numerous islands, and sandbars show that the stream is at times loaded with more earthy material than it can carry. The land between the river and the bluff on the east is a typical river bottom, marked by many bodies of stagnant water that occupy abandoned channels of the river. The map shows also the artificial levees by which most of the bottom land is protected from floods and made suitable for cultivation.

Indiana

[See Illinois-Indiana]

Iowa

- ***MELCHER**: Latitude, 41° to 41° 15'; longitude, 93° to 93° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Marion, Monroe, and Lucas counties about 35 miles southeast of Des Moines. The surface originally consisted of a fairly regular plain ranging in altitude from 940 to 1,040 feet. In this plain the streams, which are all tributary to Des Moines River, have sunk their channels to a depth of 100 to 200 feet, leaving the surface a rolling upland with steep slopes near the streams. This is essentially a prairie region, but almost every ravine contains a scanty growth of trees.

Kentucky

[See also Tennessee-Kentucky and Tennessee-Missouri-Kentucky]

- ***CUB RUN**: Latitude, 37° 15' to 37° 30'; longitude, 86° to 86° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Grayson, Edmonson, Hart, and Hardin counties, in central Kentucky. This area is hilly and rather difficult of access. It is traversed from northeast to southwest by Nolin River, which is one of the crookedest rivers in the country. The length of the river measured on a median line through its bends is about 24 miles, but the actual length measured around the bends is about 56 miles.

- ***FRANKFORT**: Latitude, 38° to 38° 15'; longitude, 84° 45' to 85°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in the "blue grass" region with Frankfort, the capital of the State, in its northern part. The surface consists of an upland plain, 800 to 900 feet above sea level, in which Kentucky River has cut a gorge whose walls are at many places 300 feet high and nearly vertical. The gorge winds across the area in great loops or meanders. In places the river has abandoned its old gorge by cutting off the narrow neck of the meander, leaving a loop-shaped valley with a flat floor that is poorly drained. A noted example is the abandoned meander in which the city of Frankfort stands.

- ***LEITCHFIELD**: Latitude, 37° 15' to 37° 30'; longitude, 86° 15' to 86° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Grayson, Edmonson, and Butler counties. The surface is hilly, and the hills rise 100 to 400 feet above the bottoms of the adjacent valleys. The beds of rock beneath the surface nearly everywhere lie flat, and hard beds here and there form flat-topped hills and ridges. In the northern part of the area sharper ridges indicate the presence of upturned beds of rock.

Louisiana

- ***SAREPTA**: Latitude, 32° 45' to 33°; longitude, 93° 15' to 93° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Webster Parish and about 15 square miles of Bossier Parish. This area includes the Spring Hill-Sarepta gas field and the recently discovered oil field of Cotton Valley. The main streams flow in flat, swampy valleys a mile or more wide, and the upland is of the gently rolling type that is generally characteristic of the Coastal Plain. The altitude ranges from 160 to 420 feet. Settlement is largely confined to the well-drained parts of the upland, and probably not over 40 per cent of the area is cleared and farmed.

Maine

- ***LONG POND**: Latitude, 45° 30' to 45° 45'; longitude 70° to 70° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Somerset County, about 15 miles west of Moosehead Lake. The surface consists generally of an upland that ranges from 1,200 to 1,500 feet above sea level, upon which stand almost conical knobs or short ridges. Bean Brook Mountain rises to a height of 2,620 feet above sea level. The country is an almost unbroken wilderness. The principal settlements and the main lines of travel are along Moose River, which crosses the area from west to east, and on Long Pond, which is an expanded part of the river. The surface of the area bears the marks of having been greatly modified by the ice sheet that passed over it in glacial time, disarranging the drainage lines, smoothing the slopes of the knobs, and dumping masses of loose material here and there.

Missouri

[See also Illinois-Missouri and Tennessee-Missouri-Kentucky]

- ***BRAYMER**: Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, $93^{\circ} 45'$ to 94° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area on Missouri River, about 20 miles north of Lexington. The surface is a gently rolling upland, 900 to 1,000 feet above sea level. Into this upland Shoal Creek has cut a broad valley, the bottom of which is irregular in outline but very flat.

- ***CHULA**: Latitude, $39^{\circ} 45'$ to 40° ; longitude, $93^{\circ} 15'$ to $93^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

The Chula quadrangle includes parts of Livingston, Grundy, and Linn counties, but only its western half is shown on the map. The surface is a rolling upland from 780 to 880 feet above sea level. The valley of Medicine Creek crosses the area from north to south. The flatness of this valley floor indicates that the flow of the stream has been arrested, causing the silt held in suspension to be dropped and the valley to be "drowned" in silt.

- ***DAWN**: Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, $93^{\circ} 30'$ to $93^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

The Dawn quadrangle includes parts of Carroll and Livingston counties, but only its northern half is shown on the map. Grand River, the largest stream in the area, crosses its northeast corner, and Shoal Creek, a tributary of Grand River, flows across it in a valley that ranges from 1 to 2 miles in width. The surface away from the streams is gently rolling and ranges in altitude from 660 to 958 feet. The valleys of both Grand River and Shoal Creek have been silted up until they are now so flat that drainage is impeded. A large drainage ditch has been cut in the valley of Shoal Creek.

- ***HALE**: Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, $93^{\circ} 15'$ to $93^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Charlton, Livingston, and Lynn counties. Only the northern half of the area bounded by the parallels and meridians indicated is shown. The area mapped is crossed by Grand River, whose valley is very flat and ranges in width from 2 to 5 miles. The upland on either side is gently rolling and ranges in altitude from 640 to 890 feet. Grand River has a very slight fall in this area. Owing to its low gradient, the river flows in a very meandering course.

- ***MAYSVILLE**: Latitude, $39^{\circ} 45'$ to 40° ; longitude, $94^{\circ} 15'$ to $94^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in De Kalb County, 50 miles northeast of Kansas City. The surface consists of a rolling upland, which has little variety in any part of the area. The divide between the drainage basins of Grand River on the east and Missouri River on the west passes through this area, and on that low ridge the highest points reach an altitude of 1,060 feet.

- ***PERRYVILLE**: Latitude, $37^{\circ} 30'$ to $37^{\circ} 45'$; longitude, $89^{\circ} 45'$ to 90° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Perry, Bollinger, and Cape Girardeau counties, just west of Mississippi River and about 65 miles from St. Louis. The gently rolling surface slopes eastward from an altitude of a little more than 800 feet to about 400 feet. A belt of nearly level land in the vicinity of Perryville is characterized by a great many sink holes, showing that it is underlain by limestone, in which there are

- ***PLATTSBURG**: Latitude, $39^{\circ} 27' 21''$ to $39^{\circ} 45'$; longitude, $94^{\circ} 15'$ to $94^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of a part of Clinton County, about 80 miles north of Kansas City. The map has been extended about 3 miles south of the Plattsburg quadrangle, to the southerly boundary of Clinton County. The highest points are 1,080 feet above sea level; but in other parts of the area the ridges are only slightly lower, attaining about 1,060 feet.

- ***WINSTON**: Latitude, $39^{\circ} 45'$ to 40° ; longitude, 94° to $94^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area about 50 miles northeast of Kansas City, lying mainly in Daviess County, but including strips of De Kalb and Caldwell counties. The surface is a gently rolling upland, which ranges in altitude from 750 to about 1,070 feet.

Missouri-Illinois

- ***CAPE GIRARDEAU**: Latitude, $37^{\circ} 15'$ to $37^{\circ} 30'$; longitude, $89^{\circ} 30'$ to $89^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in southeastern Missouri, 25 miles northwest of Cairo, Ill., mainly in Cape Girardeau County. Most of the area is part of the Ozark Plateau. The low land along the south edge belongs to the Mississippi alluvial plain.

Nevada

[See Arizona-Nevada]

New Mexico

STATE OF NEW MEXICO, topographic map. Scale, 1 inch=8 miles; contour interval, 100 meters (328 feet).

A map showing by brown contour lines the diversified configuration of the surface of New Mexico. The township subdivisions, the county boundaries, the forest and other Government reservations, and railroads, towns, and villages are shown in black; the drainage in blue. The contour lines show many notable features of the landscape that will be of interest to travelers on roads or in the air, to students of physiography, and to engineers engaged in development of railroads, automobile roads, and irrigation projects. As climate, crops, water supply, and the distribution of forests are closely related to altitude, a contour map indicates the distribution of lands suitable for various uses.

New York

ANDES: Latitude, 42° to 42° 15'; longitude, 74° 45' to 75°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area that lies mainly in Delaware County but includes small parts of Ulster and Sullivan counties. The surface consisted originally of a high but probably rolling plateau in which East Branch of Delaware River and its tributaries have cut a network of steep-sided ravines that range in depth from 500 to 1,300 feet. The hilltop ranges from about 2,300 feet to more than 2,900 feet above sea level. The highest ridge, which lies just west of Middle Mountain, is the western end of the Catskill Mountains, which rise elsewhere to a height of 4,025 feet.

ARCADE: Latitude, 42° 30' to 42° 45'; longitude, 78° 15' to 78° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area about 20 miles east-southeast of Buffalo, lying mainly in Wyoming County but including parts of Allegheny, Cattaraugus, and Erie counties. The surface is an upland which ranges in altitude from 1,800 to 2,100 feet. Many of the valleys that originally crossed the area have been partly or wholly filled by boulder clay brought in by the great ice sheet that invaded this region from the north and modified the courses of the streams. At one time the ice sheet blocked Cattaraugus Creek about 20 miles west of this area, forming a lake, the upper end of which reached the site of Yorkshire, in the southwest corner of the area.

BELMONT: Latitude, 42° to 42° 15'; longitude, 78° to 78° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Allegany County, about midway between Jamestown and Elmira, on the divide between the Mississippi and St. Lawrence drainage basins. Its northeast corner is crossed by Genesee River, whose valley, about a mile wide, is almost the only level land in the area. The rest of the area is composed entirely of hills separated by narrow valleys. If these valleys were filled the surface would be a nearly smooth plain, ranging in altitude from 2,200 to about 2,500 feet. The lowest point is in the valley of Genesee River.

ELLCOTTVILLE: Latitude, 42° 15' to 42° 30'; longitude, 78° 30' to 78° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area about 25 miles southeast of Buffalo. The surface consists almost entirely of hills and ridges, most of them rounded and few less than 2 square miles in extent. The highest of these is McCarty Hill, which reaches an altitude of 2,304 feet. If the valleys were filled the surface would be that of a sloping, somewhat rolling plain. Such was probably its condition ages ago; then the streams cut their present valleys, leaving the hills as unreduced remnants of the old plain.

RANKLINVILLE: Latitude, 42° 15' to 42° 30'; longitude, 78° 15' to 78° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area 35 miles southeast of Buffalo, lying mainly in the northeastern part of Cattaraugus County but including a strip about 3 miles wide in Allegany County. The surface consists of large hills with flat or rounded summits, which stand 2,000 to 2,200 feet or more above sea level. The hills are distributed in great groups, between which there are pronounced valleys, cut 400 to 600 feet below the level of the upland. Several of the valleys cross the area from north to south, but the drainage is divided near the middle of the area, that flowing to the south finding its way into Allegheny River and that flowing to the north reaching the Great Lakes.

PRINGVILLE: Latitude, 42° 30' to 42° 45'; longitude, 78° 30' to 78° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area 10 miles southeast of Buffalo, lying mainly in Erie County but including a few square miles of Cattaraugus County. The surface is an upland that ranges in altitude from 1,200 to 1,800 feet. The valleys of several creeks divide the upland into large rounded hills or ridges, such as abound in a large area in the southwestern part of the State, including the Finger Lake region. The sides of the valleys were long ago smoothed by the passage of glaciers over this area; since that time the numerous minor streams that flow down these slopes have carved parallel channels until the slopes are ridged like giant washboards.

Oregon

- ***LEBANON**: Latitude, $44^{\circ} 30'$ to $44^{\circ} 45'$; longitude, $122^{\circ} 45'$ to 123° . Scale, 1 inch=1 mile; contour interval, 25 feet. (New edition, showing entire quadrangle; previous edition showed only a part of the southern half.)

Map of an area in the eastern part of the Willamette Valley, just east of Albany, drained by Santiam River. The lower part of it ranges from 250 to 300 feet above sea level. Many isolated buttes and ridges rise 100 to 1,100 feet above this plain, standing out as prominent landmarks in an otherwise unbroken expanse. The highest peak in the area is Peterson Butte, 1,480 feet above sea level.

Pennsylvania

[See also West Virginia-Pennsylvania]

- ***Du Bois**: Latitude, 41° to $41^{\circ} 15'$; longitude, $78^{\circ} 45'$ to 79° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Jefferson and Clearfield counties, in the bituminous coal field, about 70 miles northeast of Pittsburgh. The surface consists of a hilly upland, which ranges in altitude from about 1,800 to about 2,000 feet. Most of the area is drained by streams that flow into Allegheny River, but a few square miles is drained by tributaries of the West Branch of Susquehanna River. The lowest point in the divide between these drainage basins has an altitude of about 1,820 feet. The lowest point in the area is on Sandy Lick Creek, 1,300 feet above sea level.

- ***MAUCH CHUNK**: Latitude, $40^{\circ} 45'$ to 41° ; longitude, $75^{\circ} 30'$ to $75^{\circ} 45'$. Scale, 1 inch=1 mile.

Map of parts of Carbon, Monroe, Lehigh, and Northampton counties, named for the town of Mauch Chunk, which stands at the east end of the Southern Anthracite field. The area is crossed by Lehigh River, which has cut its way southeastward across the plateaus and ridges of the area regardless of their height. In some of the gaps thus cut the crest of the ridge is 1,100 feet above the stream. The highest point in the area is Stony Ridge, in the northern part, which rises 1,960 feet above sea level. The lowest point, on Lehigh River at Slatington, is 360 feet above sea level.

- ***MOUNT UNION**: Latitude, $40^{\circ} 15'$ to $40^{\circ} 30'$; longitude, $77^{\circ} 45'$ to 78° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area that lies mainly in Huntington and Mifflin counties. The largest town is Mount Union, which is by air line 31 miles east of Altoona and 55 miles west of Harrisburg. The most striking surface features are the great parallel mountain ridges and the long, narrow valleys between them. Jacks Mountain, which is cut by Juniata River just west of Mount Union, is the highest ridge, attaining a height of 2,360 feet in Butler Knob.

- ***OIL CITY**: Latitude, $41^{\circ} 15'$ to $41^{\circ} 30'$; longitude, $79^{\circ} 30'$ to $79^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area that lies mainly in Venango County but includes small parts of Clarion and Forest counties. The principal town in the area is Oil City, which was the center of the petroleum industry that followed the drilling of the first oil well at Titusville, 14 miles to the north. Allegheny River crosses the northern part of the area. Near the main streams the plateau has been deeply trended by the smaller tributaries, which flow in narrow ravines about 400 feet deep. Back from the main streams the country is a rolling plateau from 1,400 to 1,500 feet above sea level. The lowest point in the area, on Allegheny River, is a little less than 1,000 feet above sea level. The highest point is a knob just south of Powell Corners, which rises to 1,700 feet.

- ***STODDARTSVILLE**: Latitude, 41° to $41^{\circ} 15'$; longitude, $75^{\circ} 30'$ to $75^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of the Pocono Plateau in Carbon, Monroe, Luzerne, and Lehigh counties, about 12 miles south of Scranton. The surface is a gently rolling plain that stands about 1,800 feet above sea level, above which many knobs and ridges rise 100 to 400 feet higher. The drainage from the plateau is carried off by Lehigh River, which crosses the area in a gorge 300 to 400 feet deep.

- ***TRONESTA**: Latitude, $41^{\circ} 15'$ to $41^{\circ} 30'$; longitude, $79^{\circ} 15'$ to $79^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area lying mainly in Clarion and Forest counties. The surface ranges in altitude from about 1,600 feet on the west to 1,700 feet on the east. Allegheny River crosses the northwest corner of the area, and Clarion River crosses its southeast corner.

South Dakota

REE: Latitude, 44° 15' to 44° 30'; longitude, 100° 15' to 100° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Hughes and Stanley counties, including the city of Pierre, the capital of the State. The undissected surface of the area stands about 1,800 feet above sea level. Into this plain Missouri River has cut a trench a little more than a mile wide and nearly 400 feet deep. Bad River, which enters the master stream just opposite Pierre, has cut a similar trench about half a mile wide. In the Ice Age a great glacier lay on the northeast side of the Missouri, and the part of the plain it covered was plastered over with debris gathered by the ice in its passage from regions far north.

Tennessee-Kentucky

LILLYDALE: Latitude, 36° 30' to 36° 45'; longitude, 85° 15' to 85° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

The Lillydale quadrangle is about equally divided between Tennessee and Kentucky. This map shows only the southern half of the quadrangle, which includes parts of Clay, Overton, and Pickett counties, Tenn. The surface consists of an upland plateau from 900 to 1,100 feet above sea level. Above this plateau rise a number of knobs that are several hundred feet higher. The highest point in the area mapped is Pilot Knob, 1,398 feet above sea level. The plateau has been trenched so deeply and completely by the small streams draining into Obey River that but little level land remains. The most striking feature shown on the map is the deeply cut, meandering channel of Obey River.

Tennessee-Missouri-Kentucky

BEELFOOT LAKE: Latitude, 36° 15' to 36° 30'; longitude, 89° 15' to 89° 30'. Scale, 1 inch=1 mile; contour intervals, 5 and 20 feet.

Map of an area that lies chiefly in Lake and Obion counties, Tenn., but includes a small part of Missouri in one of the bends of Mississippi River and a very small strip of Kentucky. This area contains Beelfoot Lake, a body of water that lies in a depression caused by the New Madrid earthquake in 1812. The lake has long been noted as the haunt of great hosts of game birds. It is now owned by the State of Tennessee, and land on the banks of the lake is being purchased for a State park and game preserve. The Mississippi bottom land stands about 300 feet above sea level and is bounded on the east by the river bluff, which rises abruptly to heights of 100 to 150 feet.

Texas

ARANSAS PASS: Latitude, 27° 45' to 28°; longitude, 97° to 97° 15'. Scale 1 inch=1 mile; contour interval, 5 feet.

Map of an area on the coast of Texas that includes parts of Aransas, San Patricio, and Nueces counties, also the well-known Aransas Pass, which is the main water highway to the Port of Corpus Christi. Facing the open water of the Gulf of Mexico are Mustang and St. Joseph islands, which are nothing more than a narrow band of sand dunes that form part of the great barrier beach that lines most of the Texas coast. Here and there the barrier beach is cut by a narrow pass that affords a means of communication between the Gulf and the protected waters of the shallow bays. Aransas Pass is one of the most traveled of these waterways. Behind the barrier beach lie Corpus Christi Bay, Redfish Bay, and Aransas Bay and several marshy islands.

AND GAS FIELDS OF THE STATE OF TEXAS. Scale, 1 inch=about 12 miles.

Map, in two sheets, showing by distinctive colors and symbols, on a new base, productive oil and gas fields, localities at which oil or gas has been produced, main pipe lines, oil refineries, and salt domes that have produced or may produce oil. Water features are printed in blue, cultural features in gray, oil fields and wells in green, gas fields and wells in red, and pipe lines, oil refineries, and salt domes in purple. The map shows the location of the Balcones fault zone.

PETRONILLAS: Latitude, 27° 30' to 27° 45'; longitude, 97° 30' to 97° 45'. Scale, 1 inch=1 mile; contour interval, 5 feet.

Map of an area in the southern part of Texas, about 100 miles from Brownsville. It lies mainly in Nueces County but includes a strip, about 4 miles wide, of the northern part of Kleberg County. The surface of the area is a very smooth plain, which ranges from 40 to 60 feet above sea level. In this plain Agua Dulce Creek, which in its upper stretches is known as Petronilla Creek, has cut a channel so recently that it has not yet been widened much beyond the space actually occupied by the water, but the small tributaries are working their way headward and will eventually dissect the plain.

Utah-Wyoming

GREEN RIVER: Plan and profile of Green River from Green River, Utah, to Green River, Wyo. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval on land 20 feet, on river surface 5 feet; vertical scale of profiles, 1 inch=20 feet. 16 sheets (10 plans, 6 profiles).

Sheets A-J show the course of Green River in the canyons it has cut through the Uinta Mountains and, by means of surface contour lines, the form of the canyon walls to a height of a few hundred feet above the level of the river. Sheets K-P show the profile of the surface of the river throughout the stretch mapped. The profile shows marked differences in slope, which depends on the character of the rocks, being very flat in the soft Tertiary rocks but steep where the river is cutting the very hard rocks of the Uinta Mountains. The steepest slope for a mile or more is in Split Mountain Canyon, where the river descends 125 feet in 5 miles.

Vermont

***BARRE:** Latitude, 44° to 44° 15'; longitude, 72° 30' to 72° 45'. Scale = 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Washington and Orange counties, just south of Montpelier. The surface is very hilly, and the hills and ridges rise 100 to 1,700 feet above the adjacent valleys. The lowest points are 520 feet above sea level, where the Winooski and Dog rivers leave the area on its northern border. The highest peak is Bald Mountain, 2,586 feet above sea level. Winooski River flows at nearly right angles to the general trend of the mountains, and its valley is a much traveled avenue of communication eastward and westward. Travel northward and southward is greatly facilitated by many long valleys, which contain well-traveled highways and lines of railroad. The map shows, east of longitude 72° 30', a strip of territory about 2 miles wide so as to include all of Barre and the great granite quarries southeast of the city.

***ENOSBURG FALLS:** Latitude, 44° 45' to 45°; longitude, 72° 45' to 73°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area that lies mainly in Franklin County and extends north to the Canadian line. It includes a small part of Lamoille County. Most of the area lies in the foothill belt on the west side of the Green Mountains, but the extreme southeast corner embraces a small part of the mountains and the northwest corner some of the terrace plains of the Lake Champlain region. The area is crossed by Missisquoi River, which flows westward to Lake Champlain. The lowest point of the surface, about 200 feet above sea level, is on Missisquoi River near Highgate, and the highest point, 1,900 feet above sea level, is the summit of Peak Mountain.

***IRASBURG:** Latitude, 44° 45' to 45°; longitude, 72° 15' to 72° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Orleans County, extending to the Canadian boundary. The most prominent feature shown is the broad valley of Missisquoi River, which here flows due north into Canada but at a point a few miles west returns into the United States and continues its course westward to Lake Champlain. West of Missisquoi River are the foothills of the Green Mountains. East of Missisquoi River is the eastern ridge of the Green Mountains, which bears the local name Lowell Mountains. The eastern border of the Green Mountains in this area is marked roughly by Black River, which flows into Lake Memphremagog, a small part of which is shown in the northeast corner of the area.

Virginia

[See also West Virginia-Virginia]

***CALLANDS:** Latitude, 36° 45' to 37°; longitude, 79° to 79° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Franklin, Henry, and Pittsylvania counties, about 18 miles from the south boundary of the State and 20 to 25 miles east of the unbroken escarpment of the Blue Ridge. The surface is a fine example of rolling plain, which ranges in height from 900 to 1,100 feet above sea level. In this plain the streams have intrenched themselves to a depth of 20 to 200 feet. Above this gently rolling surface three ridges stand as on a platform. The highest is Turkeycock Mountain, 1,840 feet above sea level. Less than half the area is under cultivation, but the cultivated lands are widely distributed.

Washington

***HANFORD:** Latitude, 46° 30' to 46° 45'; longitude, 119° 15' to 119° 30'. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of parts of Benton and Franklin counties, 50 miles due east of Yakima. The line between these counties follows Columbia River, which crosses the area from northwest to southeast. The altitude ranges from 350 to 1,200 feet above sea level. The most striking surface feature is the long line of bluffs, 300 to 500 feet high, that border the river on the east and overlook the broad plain to the west. The southern part of this plain is composed largely of sand dunes. West of Hanford Gable Mountain, a basaltic ridge 600 feet high, rises like an island above the plain.

HELLO: Latitude, $46^{\circ} 45'$ to 47° ; longitude, 119° to $119^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in southeastern Washington that embraces parts of Adams and Grant counties. A small part of Saddle Mountain is in the extreme southwest corner of the area. The principal towns are Othello and Warden.

OTENEY LAKE: Latitude, $46^{\circ} 30'$ to $46^{\circ} 45'$; longitude, 119° to $119^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in southeastern Washington, 20 miles north of Pasco, on Columbia River. The area lies mostly in Franklin County but includes a strip a mile wide in Adams County. The surface of the western part of the area is a plateau, which slopes from an altitude of about 1,300 feet to about 900 feet. East of the escarpment that bounds this plateau are a number of drainage channels that form a belt ranging in width from $3\frac{1}{2}$ to 7 miles. These channels slope southward and discharge their water into Columbia River a short distance beyond the southwest corner of the area.

West Virginia

SCLEVILLE: Latitude, $38^{\circ} 30'$ to $38^{\circ} 45'$; longitude, $79^{\circ} 15'$ to $79^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of part of Pendleton County, about 40 miles northwest of Harrisonburg, Va. The area lies in the western part of the Appalachian Valley province and contains a succession of northeastward-trending ridges and valleys. The largest valleys are those occupied by North Fork, South Branch, and Moorefield River, all branches of Potomac River, which crosses the Appalachian Valley province farther north. The highest point in the area is Kile Knob, on North Fork Mountain, 4,566 feet above sea level, and the lowest point is 1,490 feet above sea level, near Painter School, on South Branch of Potomac River.

ARBIN: Latitude, $38^{\circ} 30'$ to $38^{\circ} 45'$; longitude, $79^{\circ} 45'$ to 80° . Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of parts of Randolph and Pocahontas counties, 15 miles due south of Elkins. The area is traversed from south-southwest to north-northeast by a strip of the Allegheny Plateau, whose western edge is called Cheat Mountain. The northern part of the eastern edge of this strip is called Shavers Mountain, and the southern part is called Back Allegheny Mountain. The steep and nearly straight escarpments that bound the plateau are parallel on the west with the broad, level valley of Tygart River, a branch of Cheat River, and on the east with the very narrow valley of Greenbrier River, a branch of New River. About midway through the strip of plateau, in a crooked valley 600 to 900 feet deep, flows Shavers Fork, also a branch of Cheat River. The plateau, which is wooded throughout and almost uninhabited, reaches altitudes of 4,000 to over 4,600 feet above sea level. Its escarpments are about 1,000 feet high.

ERTON: Latitude, $38^{\circ} 45'$ to 39° ; longitude, $79^{\circ} 30'$ to $79^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area about 8 miles east of Elkins and 60 miles southwest of Cumberland, Md., lying mainly in Randolph County. The eastern two-thirds of the area lies within the Appalachian Valley province and is made up of ridges and valleys that trend about N. 23° E. The western third, a part of the Appalachian Plateaus, lies about 4,000 feet above sea level.

CLAWOOD: Latitude, $39^{\circ} 15'$ to $39^{\circ} 30'$; longitude, $79^{\circ} 30'$ to $79^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Revised map of the Kingwood quadrangle, which lies about 16 miles southeast of Morgantown. The contours and drainage are unchanged, but the culture has been revised so as to show all towns, schools, mines, and automobile roads.

West Virginia-Pennsylvania

MORGANTOWN: Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, $79^{\circ} 45'$ to 80° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Revised map of the Morgantown quadrangle, the original of which was issued in 1902. The present map shows no change in contours or in drainage, but the culture has been completely revised, showing Morgantown, now a large city, and many smaller places that have grown materially since the original map was published and others that have sprung up where coal mines have been opened.

West Virginia-Virginia

ROSS: Latitude, $38^{\circ} 15'$ to $38^{\circ} 30'$; longitude, $79^{\circ} 45'$ to 80° . Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area that lies mainly in Pocahontas County, W. Va. The boundary between the Appalachian Valley province and the Appalachian Plateaus passes through the northwestern part of this area, being marked here by the east base of Back Allegheny Mountain. Southeast of this boundary there are ridges and valleys that trend N. 35° E., and northwest of it is a plateau that stands at an altitude of about 4,900 feet.

***FORT SEYBERT**: Latitude, 38° 30' to 38° 45'; longitude, 79° to 79° 15'. Scale, 1 inch=1 mile; contour interval, 50 feet.

The Fort Seybert quadrangle embraces parts of Pendleton County, W. Va., and Rockingham County, Va., but this map shows only the part in West Virginia. The surface is marked by a number of parallel northeastward-trending ridges and valleys, which are drained mainly by Moorefield River, a tributary of the Potomac. The altitude of the surface ranges from 1,850 to 4,345 feet.

***MCDOWELL**: Latitude, 38° 15' to 38° 30'; longitude, 79° 15' to 79° 30'. Scale, 1 inch=1 mile; contour interval, 50 feet.

The McDowell quadrangle includes the southern part of Pendleton County, W. Va., and adjoining parts of Highland and Augusta counties, Va., but only the part of the area that lies in West Virginia is shown on this map. The area includes the southward continuation of the alternating ridges and valleys shown on the map of the Circleville quadrangle, W. Va. Moorefield River is the largest stream, and all the drainage flows north-northeastward to the Potomac. Shenandoah Mountain, whose crest is followed by the boundary between Virginia and West Virginia, is the longest and highest of the ridges. It attains at Reddish Knob an altitude of 4,398 feet.

***PETERSTOWN**: Latitude, 37° 15' to 37° 30'; longitude, 80° 45' to 81°. Scale, 1 inch=1 mile; contour interval, 50 feet.

Revised map of a part of the Peterstown quadrangle, representing only the area north of the crest of the ridge formed by East River and Peters Mountains, most of which lies in West Virginia. The West Virginia-Virginia boundary line follows the crest of the ridge, except at the crossing of New River, where it swings to the north, leaving as part of Virginia a tract about 4 miles wide and 6 miles long. East of New River the surface of the plateau is about 2,000 feet above sea level, but west of the river it ranges in altitude from 2,500 to 2,000 feet. This area lies south-east of the Appalachian coal field, and much of the surface rock is limestone or limy shale.

***SPRUCE KNOB**: Latitude, 38° 30' to 38° 45'; longitude, 79° 30' to 79° 45'. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of parts of Randolph, Pendleton, and Pocahontas counties, W. Va., and Highland County, Va. The surface is broken and in places rugged. It ranges in altitude from 2,100 to 4,860 feet. Most of the area is forest-covered; there are few settlements and only small areas of tillable land.

Wyoming

[See also Utah-Wyoming]

GEOLOGIC MAP OF WYOMING: Scale, 1 inch=8 miles. Issued in two forms—
(a) in two sheets, rolled, in a tube, suitable for mounting on cloth; or
(b) trimmed, pasted together, folded, and bound in a cover like those of the folios of the Geologic Atlas.

A map 38 by 56 inches showing the areal geology of the entire State in considerable detail. The base indicates the county and township lines, towns, railroads, and other works of man in black, and the drainage in blue. Geologic formations are distinguished by 51 patterns in 10 colors. Compilation of the geology from published and unpublished Survey reports and from outside sources required several years. The map will supply a long-felt need of oil companies and others interested in the development of the State and will also be of great value to educational institutions.

STATE OF WYOMING. Scale, 1 inch=8 miles.

Revised base map of the State of Wyoming. Shows in black names and boundaries of counties, national parks, national monuments, national forests, elk and bird reservations, Indian and military reservations, and railroads, towns, and small settlements, and in blue rivers, many of the smaller streams, reservoirs, and large irrigation canals. This map does not show contours.

Shaded relief maps

Besides the maps listed above, the following maps have been published in an edition on which the forms of relief are shown both by brown contour lines, as on the regular topographic map, and by shading in light grayish olive, which gives the map the appearance of a model of the surface with the light striking it from the northwest. The shading makes the inequalities of the surface more readily apparent to the inexperienced map reader than the contour lines alone.

Pennsylvania:
Milton.
Williamsport

West Virginia:
Hanging Rock.
White Sulphur Springs.

Standard symbols

STANDARD SYMBOLS adopted by the Board of Surveys and Maps, United States of America.

A colored chart, 20 by 33 inches, showing the conventional symbols to be used on maps, classified under the following headings: Works and structures, boundaries, marks, and monuments; drainage; relief; land classification; hydrography, dangers, obstructions; aids to navigation, etc.; aerial navigation; military; lettering.

GEOLOGIC BRANCH

SCOPE AND ORGANIZATION OF WORK

The work of the geologic branch was performed throughout the fiscal year by three coordinate divisions. The general organization during the year has been as follows:

Geologic branch: W. C. Mendenhall, chief geologist.

Division of geology: W. C. Mendenhall, geologist in charge.

Division of mineral resources: F. J. Katz, geologist in charge.

Division of chemistry and physics: George Steiger, chief chemist, acting in charge.

At the end of the year the division of mineral resources was transferred by Executive Order to the Department of Commerce.

APPROPRIATIONS

The acts carrying Survey appropriations for the fiscal year ending June 30, 1925 (43 Stat. 419-420, 708), provide the following amounts for the direct work of the geologic branch:

Geologic surveys.....	\$335, 562
Scientific assistants (geologists, paleontologists, and chemists).....	18, 050
Mineral resources.....	127, 940
Chemical and physical research.....	40, 000
	<hr/> 521, 552

In addition, the geologic field work requisite for the classification of mineral lands was done by means of an appropriation made for the classification of the public lands, at a total cost of \$46,300.

DIVISION OF GEOLOGY

ORGANIZATION AND PERSONNEL

The division of geology includes nine sections, as indicated below:

Geology of metalliferous deposits, G. F. Loughlin, geologist in charge.

Paleontology and stratigraphy, T. W. Stanton, geologist in charge.

Glacial geology, W. C. Alden, geologist in charge.

Geology of iron and steel metals, E. F. Burchard, geologist in charge.

Coastal Plain investigations, L. W. Stephenson, geologist in charge.

Areal geology, Sidney Paige, geologist in charge.

Geology of nonmetalliferous deposits, G. R. Mansfield, geologist in charge.

Geology of fuels, W. T. Thom, Jr., geologist in charge. (Sections of geology of oil and gas fields and geology of coal fields combined September 15, 1924.)

Petrology, C. S. Ross, geologist acting in charge.

In addition to the units of administrative organization the division includes two administrative committees—the committee on geologic names, T. W. Stanton, chairman, and the physiographic committee, M. R. Campbell, chairman. These committees consider

in detail all problems falling within their respective fields and advise the chief geologist of their findings as a basis for administrative action.

The division also exercises technical supervision over the section of geologic map editing and administrative control over the Hawaiian Volcano Observatory, of which T. A. Jaggar, jr., is in charge, at the Kilauea Volcano.

At the beginning of the fiscal year the division included 132 geologists of various grades. During the year 6 resigned; 19, mostly members of college faculties who were serving on a basis of pay "when actually employed" and who had in recent years devoted little time to Survey work, were dropped from the Survey rolls; 2 were retired; and 3 were added to the force, so that the number on the rolls at the end of the year was 108. The division included 4 draftsmen (2 temporary), 1 having died during the year, and 5 preparators of fossils, 1 having been appointed and 2 having retired during the year. In the clerical and messenger force there were 6 accessions and 6 separations, leaving a total of 31 employed at the end of the year.

K. C. Heald, who had had charge of the section of geology of oil and gas fields since January 1, 1921, resigned to accept an assistant professorship at Yale University.

At the end of the year C. Whitman Cross and W. H. Dall were automatically retired from the service, having reached or passed the retirement age. Each of them is a leader in his particular field, and each had been connected with the Survey for more than 40 years. Doctor Cross is best known for his excellent geologic studies in the mountain region of Colorado, for his leadership in petrologic work, and as one of the authors of the quantitative system of rock classification. Doctor Dall is a widely recognized authority on Tertiary and living mollusks.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the division of geology for the fiscal year were as follows:

Geologic surveys.....	\$335,562
Classification of lands.....	46,300
Scientific assistants.....	14,233
Search for potash deposits (allotted from appropriation for chemical and physical research).....	3,850
Repayments, etc.....	2,127
	<hr/> 402,072

The expenditures from these funds may be classified by subjects approximately as follows:

Hawaiian volcanology.....	\$10,850
Geology of metalliferous deposits.....	70,000
Geology of nonmetalliferous deposits.....	13,250
Geology of fuels (oil, gas, coal).....	84,300
Scientific researches not directly connected with economic geology (paleontology, glaciation, Coastal Plain forma- tions, etc.).....	123,000
Supervision, administration, salaries of clerical, technical, and skilled-labor forces, purchase and repair of instru- ments, office supplies, etc.....	100,000
Unexpended balance.....	672
	<hr/> 402,072

Of the amounts available for geologic work, approximately \$5,000 was used directly to pay field expenses, including those incurred in the search for potash. About 70 per cent of this amount was expended for work done west of the one hundredth meridian and about 30 per cent for work done east of it.

COOPERATION

The Geological Survey cooperates with other organizations, State and Federal, by assigning its members to the study of special problems, either wholly or partly at the expense of the organization that requests the cooperation. During the year the Forest Service, the General Land Office, the Office of Indian Affairs, the Department of Justice, the Bureau of Reclamation, several States, and the National Research Council thus received the benefit of the special training available in the branch. The cost to the cooperating organizations, in the form of salaries assumed or field expenses borne, was \$9,659.

Examples of such cooperative work with State surveys are the completion of a geologic map and an accompanying report giving description of the rock formations of Arizona, the preparation of a geologic map of Alabama and an accompanying text, and the preparation of a geologic map of Oklahoma. The Oklahoma map was prepared in cooperation with the State Geological Survey and the oil geologists and oil companies of the State through the National Research Council. In cooperation with the Oklahoma Geological Survey a map showing the geologic structure of northeastern Oklahoma was compiled from data furnished by the cooperating organizations and by oil companies that have operated in this region. This map was published by the Federal Survey for the State.

Among other results achieved by cooperation are a report on the physical geography of Georgia, published by the Georgia Geological Survey; a report on the Valley coal fields of Virginia, published by the Virginia Geological Survey; and a report on the geology and oil possibilities of Russell County, Kans., to be published by the Kansas Geological Survey.

The identification of fossils sent in from different parts of the United States and from Canada, the West Indies, Central and South America, Africa, China, and Japan is a cooperative service of great usefulness to various scientific organizations but more particularly to the oil companies that are now scouring the world for a new supply of petroleum.

In its capacity of expert adviser in the solution of problems involving geology and mineral economics the cooperation of the Survey is increasingly requested by Federal departments and bureaus. Such cooperation was maintained with the Office of Indian Affairs in matters involving the leasing of oil lands in Indian reservations, with the Bureau of Reclamation in the examination of reservoirs and dam sites, and with the Forest Service in the examination of proposed extensions to national forests.

The Hawaiian Volcano Research Association also cooperates with the Survey in the publication of the Monthly Bulletin of the Hawaiian Volcanic Observatory.

GENERAL REVIEW OF THE WORK OF THE YEAR

The work of the year, which is set forth below in detail by States, has been, as heretofore, so directed as to assist the economic development of the country's mineral resources. It is gratifying, however, that many so-called "purely scientific" investigations are by-products of the work of solving "practical" problems.

The geologic work that affords the basis for the classification of coal lands goes steadily forward from year to year by the use of such funds as are available for it. In connection with this work certain kinds of research concerning coal are pressingly demanded, such as research regarding its composition, its origin, its classification, and its special fitness for use in particular industries.

The general study of oil fields and of oil-field problems has been continued throughout the year. This work has included studies of structure in developed fields and undeveloped areas, studies of the relations of pools to structure, and inquiries as to the origin of oil. One of the more recent lines of investigation is the study by the aid of the microscope of the character of the oil sands and the micro-organisms that they may contain, in order to identify these sands even though they may lie at a depth of several thousand feet. By such methods well logs in a field can be more accurately compared, and the underground structure can be determined in places where the surface structure is obscured or where the structure at depth does not correspond with that at the surface.

Throughout the year the study of the origin and distribution of oil shale and the nature of the contained organic material from which oil may be derived by destructive distillation has been continued, and much information has been gained by microscopic, chemical, biologic, and botanic studies. The results of these studies may have an important bearing upon the commercial uses to which this shale may be put in the search for oil when failing supplies necessitate the location of the less easily exploited sources.

A graphic exhibition of the work of the Survey of interest to the petroleum industry was prepared and installed at the International Petroleum Exposition and Congress in Tulsa, Okla., October 2-11, 1924.

The present year witnessed the completion of three important investigations in metalliferous geology. One of these, covering the Leadville district of Colorado, has yielded a report which is now in the hands of the editors and illustrators; for another, covering the copper region of Lake Superior, the field work has been completed, and the preparation of a report is well advanced; and for the third, covering the Mother Lode of California, the field work is completed and the report is in preparation.

The Survey is carrying on a number of investigations in different parts of the country that are throwing additional light on structural problems—that is, on the forms that rocks assume under intense pressure in the earth's crust, the conditions under which such stresses originate, and the way in which they have operated in the geologic past. Among these studies are several worthy of mention here. (1) The examinations, noted in the following pages, of domes and anticlines that may contain oil, though these are

comparatively simple structural features, have led to some significant conclusions regarding the form that rocks assume under various stresses. (2) The study of broad areas in the basin and range province, mainly in Nevada, has disclosed the most complicated geologic structure, the result of stresses acting in different directions and at different times in the past, in what has been generally supposed to be a region of very simple faulted blocks of the earth's crust. (3) A cooperative investigation has resulted in a report published by the Virginia Geological Survey which describes in considerable detail one of the largest overthrust faults known in the Appalachian region, in which the plane of the fault has been folded and the overthrust mass rests upon coal beds of considerable economic importance.

WORK OF THE YEAR BY STATES

ALABAMA

Field.—In connection with the revision of the geologic map of Alabama to be issued by the State in cooperation with the United States Geological Survey, Charles Butts completed studies of the Paleozoic areas; L. W. Stephenson did supplemental work on geologic boundaries of the Cretaceous in east-central Alabama; and O. W. Cooke, assisted by W. S. Hoffmeister and Stuart Mossom, completed studies of the Tertiary formations. E. F. Burchard examined bauxite in Colbert County, and C. S. Ross visited numerous arsenic prospects near Cragford.

Office.—The revised cooperative geologic map of the State has been completed by Messrs. Butts, Stephenson, and Cooke, and the text to accompany it is in preparation, Mr. Butts preparing the description of the Paleozoic areas and Messrs. Stephenson and Cooke that of the Cretaceous, Tertiary, and Quaternary formations. E. F. Burchard, assisted by Charles Butts, prepared a paper on the economic geology of the Birmingham district for the American Institute of Mining and Metallurgical Engineers. H. D. Miser prepared a short paper on rocks penetrated by a well near Florence (Bulletin 781-A). G. H. Girty has in preparation a paper on the Carboniferous fauna from the town of Trinity.

ARIZONA

Field.—Edward Sampson completed a field examination of asbestos near Globe, Ariz.; G. I. Finlay, assisted by Carle H. Dane, completed a reconnaissance examination of the Four Corners area of Arizona and Utah, for land classification. F. L. Hess visited deposits of rare metals at Copper Creek, Table Mountain, Dripping Springs, Casa Grande, Bisbee, and the Huachuca Mountains. D. F. Hewett examined manganese deposits near Agulla. F. E. Matthes accompanied the congressional subcommittee on appropriations for the Department of Interior through Grand Canyon National Park.

Office.—N. H. Darton completed the geologic map of Arizona and the report on the geology of the State, in cooperation with the Arizona Bureau of Mines and Geology, which is to publish the map and report. He also prepared for the American Association for the Advancement of Science a paper on the geologic map of Arizona. G. I. Finlay and C. H. Dane prepared for the land-classification branch a report on the Four Corners area. C. P. Ross read proof of his papers on the Aravaipa and Stanley mining districts (Bulletin 763) and the Banner and Saddle Mountain districts (Bulletin 771). D. F. Hewett prepared for publication in the Engineering and Mining Journal-Press a brief report on the occurrence of carnotite near Agulla. M. N. Short is preparing a paper on the origin of deep-level chalcocite at Superior. C. R. Longwell prepared a report on the geology of the Muddy Mountains, Nev., which includes a section on the Grand Wash Cliffs in western Arizona. G. H. Girty studied Carboniferous and Lower Triassic fossils from the State.

Publications.—Bulletin 763; Press Notice 2119, on the Aravaipa and Stanley mining districts.

ARKANSAS

Field.—R. D. Mesler collected fossils near Gilbert and Tomahawk, Ark., in connection with stratigraphic studies of the region. H. D. Miser visited several manganese mines in the Batesville district and collected fossils from the Batesville sandstone (Carboniferous). E. F. Burchard examined bauxite in the Little Rock district. T. W. Stanton made a field study of the stratigraphy and paleontology of the Lower Cretaceous (Comanche series) at Murfreesboro in the Caddo Gap quadrangle. C. H. Dane made a brief examination of the Cretaceous outcrop in southwestern Arkansas. L. W. Stephenson studied the stratigraphic and age relations of Upper Cretaceous formations in the vicinity of Ben Lomond, Sevier County.

Office.—W. C. Mendenhall, W. T. Thom, jr., H. D. Miser, and L. W. Stephenson conferred with G. C. Branner, State geologist, concerning the preparation of a cooperative geologic map of Arkansas and a report on oil resources of the Coastal Plain of the State. E. W. Berry conferred with the State geologist regarding the study of fossil plants from Arkansas. H. D. Miser assembled the Geological Survey's unpublished geologic maps for use in preparing the geologic map to be published by the State. He also prepared a few paragraphs on manganese in the Batesville district for Mineral Resources, 1923. H. D. Miser and C. S. Ross prepared a paper on the volcanic material in the Upper Cretaceous of southwestern Arkansas and southeastern Oklahoma, which was published in the American Journal of Science early in 1925, and they began the preparation of an official report on the same subject. G. H. Girty continued work on a report on the fossil fauna of the Morrow formation of Arkansas. He also studied the Boone fossil fauna at Batesville and began the preparation of a paper on the Batesville fauna. L. W. Stephenson studied fossils from the Upper Cretaceous (Gulf series) of Arkansas, in connection with the preparation of a paper on the stratigraphy of the Gulf series of Texas. R. D. Mesler studied Beekmantown fossils and fossils from the proposed Ozarkian system of E. O. Ulrich, and E. W. Berry reported on collections of fossil plants from Arkansas.

CALIFORNIA

Field.—W. P. Woodring and P. V. Roundy, assisted by H. W. Hoots, completed the mapping of the geology of the Elk Hills district, Calif., in Naval Oil Reserve No. 1. H. W. Hoots mapped the structure and studied the stratigraphy of the Wheeler Ridge district and the area extending from the edge of the San Emigdio foothills west to San Emigdio Creek. W. C. Mendenhall and P. V. Roundy visited this district with Mr. Hoots. Adolph Knopf, assisted by T. B. Nolan, made a detailed study of the gold veins of the Mother Lode belt. F. L. Hess examined deposits of rare metals and collected samples of ores. H. G. Ferguson did geologic field work in the Allegheny-Grass Valley region. G. F. Loughlin spent a few days in studying the North Star mine, at Grass Valley. E. S. Larsen and W. T. Schaller investigated the geologic conditions that control the formation of pegmatites and their associated rare minerals in the vicinity of Pala and Mesa Grande. D. F. Hewett carried on field studies in the Ivanpah quadrangle. L. F. Noble examined a colemanite deposit at Red Mountain, near Shoshone; made stratigraphic studies in the Death Valley region, studying the Tertiary beds near Tecopa Pass, on the border of Pahrump Valley; and made a short trip with H. S. Gale to the Kramer borax mine. He examined in company with Prof. William M. Davis the region along the San Andreas rift through Cajon Pass to Valerino and examined the Pacolma and Santa Anita dam sites for the chief engineer of the Los Angeles County flood-control district. F. E. Matthes accompanied the congressional subcommittee on appropriations for the Department of the Interior through Sequoia National Park. He also made a physiographic reconnaissance through the Tehipite quadrangle. C. D. Avery collected oil data in San Francisco and Los Angeles and, with H. W. Hoots, made field investigations and collected oil data in Bakersfield, Taft, and Maricopa and in the vicinity of Devil's Den, Tur Creek, Timber Creek, and the Piper and Temescal wells.

Office.—F. E. Matthes completed the revision of his bulletin on the origin of Yosemite Valley, and F. C. Calkins completed his report on the bedrock of the Yosemite region. Mr. Matthes continued work on his report on

the physiography of the upper San Joaquin basin and made preliminary studies for work in the Kings River basin. He also prepared a paper on evidences of recurrent glaciation in the Sierra Nevada for the National Academy of Sciences, and another on the Devil's Postpile, in the Sierra Nevada, for presentation to the American Association for the Advancement of Science. K. C. Heald read and edited a report by W. S. W. Kew on oil in southern California and, with C. E. Dobbin and W. T. Thom, jr., a report by W. A. English on the geology and oil resources of the Puente Hills. T. W. Stanton held conferences with geologists at San Francisco, the University of California, and Stanford University, and studied fossil collections at the two universities. L. F. Noble continued the preparation of his report on salines in California, nearly completed the study of the Kalbab limestone section in Buckskin Gulch, made some progress on his paper on the Leach Trough fault, and continued work on the San Andreas rift. Adolph Knopf and T. B. Nolan have in preparation a report on the resurvey of the Mother Lode district. H. W. Hoots prepared a report on the geology of the Wheeler Ridge and adjoining San Emigdio Hills, Kern County, for the land-classification branch, and has in preparation a report on the same subject for Survey publication. W. H. Dall studied fossils from Eagle Lake, Catalina Island, San Pedro, and other areas; prepared a paper on the Pleistocene fauna of San Pedro, for the Proceedings of the United States National Museum; and reported on fossils received from R. H. Palmer, Stanford University. F. H. Knowlton studied and reported on fossil plants from auriferous gravel. Edwin Kirk reported on Devonian fossils. H. G. Ferguson has in preparation a report on the geology and ore deposits of the Allegheny district. W. P. Woodring and P. V. Roundy are writing a report on the geology and oil resources of the Elk Hills district. A report was prepared by Mr. Woodring for the land-classification branch on sec. 16, T. 30 S., R. 23 E., and another on the geology of San Nicolas Island.

Publications.—Bulletin 753; Press Notice 18183, "Oil in southern California."

COLORADO

Field.—F. L. Hess continued the field examination of uranium and other rare minerals in Colorado. J. B. Eby continued field work in the east end of the Yampa coal field, mapping the Pilot Knob quadrangle and doing special work in the Daton Peak and Mount Harris quadrangles. M. R. Campbell, assisted for a short time by A. A. Baker and then by N. W. Bass, mapped in the spring of 1925 the Mount Harris quadrangle, in the extreme southeast point of the Yampa coal field, and reexamined certain areas in the Daton Peak and Pilot Knob quadrangles. Kirtley Mather, James Gilluly, and R. G. Lusk completed reconnaissance studies of the possibilities of oil in north-eastern Colorado. W. H. Bradley, assisted by C. E. Erdman, completed geologic mapping of oil-shale lands in Rio Blanco County, and Mr. Bradley made a reconnaissance survey of Naval Oil Shale Reserve No. 1. W. W. Boyer completed his examination of coal outcrops in the Red Mesa and Ignacio quadrangles and in company with J. B. Reeside, jr., visited certain localities in the Red Mesa quadrangle for the purpose of making a study of Mesozoic and Tertiary stratigraphy. C. E. Dobbin and Mr. Reeside made a reconnaissance examination of the Fox Hills, Laramie, Arapahoe, and Denver formations in the Denver Basin. G. F. Loughlin studied new mine developments at Leadville and in the Cripple Creek district.

Office.—C. W. Cross, E. S. Larsen, and C. S. Ross continued the preparation of reports on the geology of the San Juan region, and W. W. Atwood and K. F. Mather brought nearly to completion their report on the Quaternary geology and physiography of the same region. A paper on physiographic surfaces in the Front Range of Colorado and their equivalents on the Great Plains was prepared by K. F. Mather for presentation to the Geological Society of America. G. F. Loughlin completed the revision of the Leadville report and began work on a paper entitled "Guides to ore at Leadville." W. H. Bradley submitted an informal report on topography, drainage, and trails of Naval Oil Shale Reserve No. 1 and revised the map of oil-shale reserves in Colorado, for the Navy Department. A paper on the origin of the Green River formation was written by Mr. Bradley for publication in the Bulletin of the American Association of Petroleum Geologists. He also prepared a report on the stratigraphy of the Green River formation in the Uinta Basin. F. H. Knowlton reported on fossil plants from the Green River formation. K. F. Mather, James Gilluly,

and R. G. Lusk worked on a report on the oil and gas prospects of northeastern Colorado, and Mr. Mather, assisted by Mr. Lusk, wrote a press bulletin on oil and gas prospects in that region, and one on the probable depth of the Dakota sand in northeastern Colorado. Adolph Knopf completed a brief report on recent developments in the Aspen district. W. W. Boyer and J. B. Reeside, jr., wrote a press notice on prospects for oil and gas in and near the Barker Creek dome, Colorado and New Mexico, and Mr. Boyer prepared land-classification data covering coal cases in that district. Mr. Boyer also prepared township reports on coal classification in the Grand Mesa coal field and a report and map of the Cinder Buttes coal field, La Plata County. J. B. Eby prepared land-classification data on the eastern part of the Yampa coal field and wrote a press notice on analyses of the Yampa coals. He wrote a preliminary draft of a report on the eastern Yampa area, the paleontologic parts of which were revised by Mr. Reeside; a paper on contact metamorphism of coals in Colorado, which he presented before the American Institute of Mining and Metallurgical Engineers; and a press notice regarding oil and gas possibilities in the Slater dome, Routt County. W. T. Thom, jr., and J. B. Eby revised the report of E. T. Hancock on geology and coal resources of the Meeker quadrangle, Moffat and Rio Blanco counties. Sidney Paige prepared a paper on the relation of the La Plata formation of southwestern Colorado to the plateau group in the plateau county of Colorado for the American Association for the Advancement of Science. G. H. Girty studied Carboniferous fossils. E. O. Ulrich and R. D. Mesler prepared fossils obtained from formations belonging to the system Mr. Ulrich proposes to call Ozarkian. J. B. Reeside, jr., and T. W. Stanton studied Cretaceous invertebrates. W. T. Lee revised his report on the correlation of formations in eastern Colorado and central Wyoming. C. S. Ross began a paper on the petrology of Fortification Rocks, near Craig.

Publications.—Bulletins 750-C, 750-D, 751-G, 757; Professional Paper 132-F, 134; press notices on the Yampa coal field (No. 17848), prospects for oil or gas in the Slater dome, in northwestern Colorado (No. 17987), oil and gas in northeastern Colorado (No. 17854), prospects for oil and gas in and near the Barker Creek dome, Colorado and New Mexico (No. 17976), and estimated depth of sandstone in northeastern Colorado that may yield oil (No. 1522).

CONNECTICUT

Arthur Keith and Laurence LaForge held a conference in eastern Connecticut with Dr. William N. Rice, Prof. W. G. Foye, and Prof. H. P. Little on the possible southward extension of the Carboniferous rocks of central Massachusetts into Connecticut.

DISTRICT OF COLUMBIA

Arthur Keith collected geologic data revealed by excavations in the District of Columbia.

FLORIDA

Field.—C. W. Cooke conferred with the assistant State geologist relative to the correlation of Florida limestones, studied coastal terraces, and examined outcrops of the Tampa and Ocala formations. Julia Gardner studied the geology of Tampa and vicinity.

Office.—Julia Gardner continued studies of fossils from the Alum Bluff group, transmitted Part IV of her report on the Mollusca of Alum Bluff of Florida, revised Part V, and incorporated in the first three parts the results of her study of fossils received since they were written. J. T. Pardee prepared reports on the classification of phosphate lands near Ocala and in the central and northern parts of the State. W. C. Mansfield began a paper on the Choctawhatchee marl of Florida. W. H. Dall reported on Pliocene fossils.

GEORGIA

Field.—Charles Butts examined lands in northern Georgia for the Forest Service, in conformity with the Weeks Act. C. S. Ross visited copper, gold, and asbestos mines at Lincolnton and near Thompson, Dahlonega, Cleveland,

Hollywood in connection with a reconnaissance of the metalliferous deposits of the eastern United States. C. W. Cooke studied the coastal terraces of the State.

Office.—C. W. Cooke, M. R. Campbell, Arthur Keith, and Laurence LaForge completed the cooperative report on the physical geography of Georgia, which was published by the Georgia Geological Survey. Julia Gardner wrote a short paper on the Marks Head marl of Georgia for outside publication. Charles H. Hays prepared a report on his examination of lands in northern Georgia for the Forest Service. C. W. Cooke wrote a paper on the coastal terraces of Georgia, for presentation to the American Association for the Advancement of Science.

HAWAII

F. A. Jaggard, jr., and R. H. Finch continued observations at the Hawaiian Volcano Observatory, Kilauea Volcano. Mr. Jaggard joined the expedition of the U. S. S. *Whippoorwill* to explore the islands of Howland and Baker. The monthly Bulletin (published in cooperation with the Volcano Research Association) and the Volcano Letter, a weekly news leaflet of the Hawaiian Volcano Research Association, were issued. W. H. Dall reported on fossils from Midway Island for D. Thasnum, and also on fossils from Hawaii. R. H. Finch prepared articles on earthquakes at Kapoho, Island of Hawaii, in April, 1924; on seismic sequences of the explosive eruption of Kilauea in May, 1924, for publication in the Bulletin of the Seismological Society of America.

IDAHO

Field.—E. F. Burchard inspected deposits of iron ore in Idaho, accompanied on one trip by F. B. Laney, of the Idaho Bureau of Mines and Geology. Edward Sampson did geologic field work in the Pend Oreille area, in cooperation with the Idaho Bureau of Mines and Geology. C. P. Ross completed field work in the Wood River region, made some examinations on Salmon River between Challis and Stanley, completed field work on the quicksilver deposits at Yellow Pine, and, assisted by W. H. Newhouse, began field investigations in the Castro quadrangle. J. T. Pardee examined sections of land near Driggs, Idaho, for phosphate.

Office.—Edward Sampson and J. L. Gillson continued the preparation of a cooperative report on the Pend Oreille district. Mr. Sampson gave a paper on native arsenic from northern Idaho, jointly with Mr. Gillson, at the New York meeting of the Society of Economic Geologists. D. F. Hewett and W. T. Haller prepared an article on the genesis of hisingerite in the Wood River district, Blaine County, for publication in the American Journal of Science. C. Schrader and C. P. Ross wrote a report on the antimony and quicksilver deposits of the Yellow Pine district. G. R. Mansfield revised his report on the geology and mineral resources of southeastern Idaho, which was submitted for publication; reviewed material for a paper on the physiography of southeastern Idaho for the Geological Society of Washington; and prepared a discussion of V. R. D. Kirkham's paper on phosphate in Idaho in relation to world supplies, which was transmitted to the American Institute of Mining and Metallurgical Engineers. He also prepared a paper on the origin of the Phosphoria formation, for delivery before the Society of Economic Geologists, reported on the classification of phosphate lands in the Portneuf quadrangle, and continued work on his report on this quadrangle. C. P. Ross completed a paper on the Wood River district of the Halley quadrangle and revised the paper on the general geology of this quadrangle originally written by L. G. Sloss. He also wrote a paper for publication in the Pan-American Geologist. Tertiary planation in eastern Oregon and central Idaho, and also one for presentation before the American Association for the Advancement of Science. L. Gillson rewrote a paper on zircon, a contact mineral at Pend Oreille, for official publication. G. H. Girty studied and reported on Carboniferous fossils; W. H. Dall reported on Pleistocene fossils; and F. H. Knowlton reported on Pleistocene fossil wood. A paper was prepared by J. P. Buwalda on the geology of the Payette formation and the old erosion surface in Idaho for publication in Science.

Publications.—Bulletin 750-F, Professional Paper 132-G.

ILLINOIS

E. F. Burchard visited several points in Illinois in connection with Mineral Resources work on cement. G. H. Girty studied Carboniferous invertebrate fossils, and F. H. Knowlton reported on a collection of fossil plants from Illinois for the Colorado Museum.

INDIANA

G. F. Loughlin is preparing a report on Indiana limestone.

IOWA

Field.—M. I. Goldman examined gypsum deposits at Fort Dodge, Iowa. Frank Leverett had a field conference with Prof. G. F. Kay, State geologist, on the interpretation of glacial features of Iowa.

Office.—G. H. Girty studied Carboniferous fossils of the State and continued work on his report on the typical Kinderhook fauna.

KANSAS

Field.—Frank Leverett studied glacial drift and associated deposits in the northeastern part of Kansas and carried on field work with a view to determining the extent of the ice in the first glacial stage, as compared with that of the second stage. The Director, the chief geologist, David White, K. C. Heald, W. T. Thom, jr., and R. C. Moore, State geologist, held a conference concerning general cooperative projects in Kansas, and later W. T. Thom, jr., W. W. Rubey, N. W. Bass, and R. C. Moore conferred regarding special lines of investigation to be carried out. Mr. Bass in the course of cooperative work collected well data, mapped geologic structure, and measured sections in Rooks, Hays, Ellis, Rush, Hamilton, Trego, Barton, Ness, and Hodgeman Counties. He visited the Dakota outcrop in Morton and Stanton counties and the Greenhorn outcrop in southeastern Gray County. W. C. Mendenhall accompanied him on a reconnaissance trip from Syracuse east and north to Ellis and Russell counties, thence south to Great Bend. M. I. Goldman studied gypsum deposits at Wichita. W. T. Thom, jr., visited the Rainbow Bend oil district, and E. F. Burchard in connection with Mineral Resources work on cement visited several localities in the State.

Office.—N. W. Bass prepared press notices on the Syracuse anticline and the geologic structure of western Kansas, to be issued by the Kansas Geological Survey. He also began cooperative reports on Ellis County, Hamilton County, Kansas stream valleys, and the salt deposits of western Kansas. J. B. Reside, jr., reported on Cretaceous fossils collected by N. W. Bass in central and southwestern Kansas and by W. W. Rubey and N. W. Bass in Russell County and revised paleontologic parts of their report on this region. A cooperative report on Russell County by R. C. Moore, W. W. Rubey, N. W. Bass, and M. N. Bramlette was completed in June and submitted for publication as a bulletin of the State Geological Survey. K. C. Heald compiled data regarding the Americus limestone of Kansas and the Foraker limestone of Oklahoma for a discussion of their correlation. P. V. Roundy examined fossils and well cuttings in connection with his studies of micropaleontology. F. H. Knowlton reported on Dakota fossil plants. T. W. Stanton reviewed a report on the fauna and stratigraphy of the Comanche rocks.

KENTUCKY

Field.—Frank Leverett studied the Pleistocene geology of Kentucky for the Kentucky Geological Survey while on leave without pay. W. T. Lee examined Mammoth Cave and took many photographs of its stalactites and stalagmites, in the interest of the Southern Appalachian National Park Commission.

Office.—W. T. Lee summarized the results of his investigations in Mammoth Cave and submitted a report to the Southern Appalachian National Park Commission. Frank Leverett prepared a report on the Pleistocene formations of Kentucky for the State Geological Survey.

LOUISIANA

Field.—C. H. Dane examined, to obtain data for land classification, the prospective and partly developed oil and gas districts of Cotton Valley, Spring Hill, Shongaloo, Urania, and Oakland, La. He conferred with the State Conservation Department and oil geologists regarding the status of development of several other fields in Louisiana, including those of Lake Charles and Lockport, and examined Cretaceous outcrops on some salt domes in the northern part of the State. W. T. Thom, jr., conferred with members of the Louisiana State Conservation Commission and with members of the Shreveport Geological Society regarding the surface and subsurface geology of northern Louisiana and visited the Cotton Valley and other fields. L. W. Stephenson examined Cretaceous outcrops at the Prothro and Rayburn salt domes, Bienville Parish, and the cap rocks at the Winnfield salt dome, Winn Parish.

Office.—M. I. Goldman continued petrographic studies of cap rock from salt domes of Louisiana and Texas and rewrote his paper on this subject for publication in the bulletin of the American Association of Petroleum Geologists. K. C. Heald wrote a short paper on sandstone inclusion in salt in mine on Avery's Island. W. C. Mansfield prepared a report on Eocene fossils from the State. T. W. Stanton examined fossils from a deep well in northern Louisiana, and E. W. Berry worked on fossil plants from the State. L. W. Stephenson studied fossils from the Upper Cretaceous (Gulf series) in connection with the preparation of a paper on the stratigraphy of the Gulf series of Texas. C. H. Dane prepared reports for the land-classification branch on the Urania, Oakland, Lockport, and Lake Charles districts.

MAINE

W. H. Dall reported on fossils from Maine. W. S. Burbank prepared a cooperative report on the petrology of the sediment of the Gulf of Maine and Bay of Fundy, for the United States Bureau of Fisheries.

MARYLAND

Field.—G. R. Mansfield made a trip to diatomaceous earth deposits west of Dunkirk, Md. A. I. Jonas, for the Maryland Geological Survey, continued cooperative field work in Carroll, Frederick, and Montgomery counties. W. C. Mansfield examined Miocene strata and collected fossils along the Calvert Cliffs, from Parkers Creek to and beyond Cove Point; he also studied Pleistocene deposits and fossils at Walles Bluff and Langley Bluff. L. W. Stephenson made field investigations in St. Marys County, in connection with Mr. Mansfield's study of late Tertiary and Quaternary faunas of the Atlantic Coastal Plain.

Office.—The Carroll County report was continued by A. I. Jonas, and a final geologic map was transmitted to the State geologist of Maryland. Some time also was given by Miss Jonas to the map of Frederick County. W. C. Mansfield examined Pleistocene fossils from Walles Bluff and Langley Bluff and prepared a paper on Pleistocene mollusks collected by himself at these localities. Mr. Mansfield also began a paper on the climatic conditions indicated by the molluscan fauna of the Chesapeake group of Maryland and Virginia.

MASSACHUSETTS

Field.—Laurence LaForge examined the Skinner coal mine, near West Mansfield, Mass. L. M. Prindle continued geologic work in the Greylock and Berlin quadrangles. Arthur Keith and Laurence LaForge conferred with Dr. William N. Rice, Prof. W. G. Foye, and Prof. H. P. Little on the possible southward extension of the Carboniferous rocks of central Massachusetts into Connecticut.

Office.—Work on the Taconic folio was continued by L. M. Prindle. Laurence LaForge wrote an informal report on the Skinner coal mines, and he also continued the preparation of the Boston folio. W. T. Thom, jr., prepared recommendations regarding prospecting for coal in the Narragansett Basin, southwestern Massachusetts, for the Massachusetts Special Commission on the Necessaries of Life. W. C. Alden prepared a paper for presentation at a meeting of Clark Geographers at Clark University on the physiography

and glacial geology of central Massachusetts. W. H. Dall reported on fossils from Marthas Vineyard.

Publication.—Bulletin 700-B.

MICHIGAN

Field.—B. S. Butler and his assistant, W. S. Burbank, continued geologic studies in the Michigan copper district. E. O. Ulrich consulted with representatives of the Michigan State Survey and of the University of Michigan at Ann Arbor with regard to the preparation of a new classification of the Paleozoic rocks of the State and a new geologic map of Michigan. Frank Leverett studied and mapped surficial geology in Alpena and Roscommon counties in cooperation with the Michigan Geological Survey. E. F. Burchard visited several localities in Michigan in connection with Mineral Resources work on cement.

Office.—B. S. Butler, assisted by W. S. Burbank, worked on the text and illustrations of his general report on the geology and ore deposits of the Michigan copper region and prepared a geologic map of the south end of the region. G. H. Girty began a report on the fauna of the Marshall sandstone and also worked on Carboniferous fossils of the State. Frank Leverett, in continuation of his cooperative work, revised his report on the surface geology and agricultural conditions of Antrim and Ogemaw counties for publication by the Michigan Geological Survey.

MINNESOTA

Frank Leverett continued work on a report on the surficial geology of Minnesota. F. H. Knowlton prepared a report on fossil plants from Minnesota for C. J. Hodgson, of the Coast and Geodetic Survey.

MISSISSIPPI

Field.—C. W. Cooke, assisted by Stuart Mossom, did some field work in Mississippi on the revision of the geologic map of the State.

Office.—L. W. Stephenson began the revision of a report on the ground waters of Mississippi. C. W. Cooke revised the map of the Claiborne and Wilcox groups (Eocene) for the revised geologic map to accompany cooperative reports on the general geology and ground waters of the State. M. N. Bramlette and H. D. Miser prepared a report on well-log correlations in northeastern Mississippi and northwestern Alabama. O. C. Postley wrote a press bulletin on possibilities of the Vicksburg-Jackson area.

Publications.—Bulletin 750-G; Press Notice 18088, on possible oil and gas near Vicksburg and Jackson.

MISSOURI

Field.—Frank Leverett examined the Pleistocene deposits on Mississippi River in the region of Cape Girardeau, Mo. E. F. Burchard visited several places in Missouri in connection with Mineral Resources work on cement.

Office.—C. E. Slebenthal made a map of the lead regions in southeastern Missouri for the Bureau of Mines. G. H. Girty worked on a report on the Pennsylvania faunas of the Joplin region and studied and reported on Carboniferous fossils from Missouri. R. D. Mesler prepared fossils collected by E. O. Ulrich, members of the Missouri Geological Survey, and himself. E. O. Ulrich worked on the Eminence faunas from Missouri localities.

MONTANA

Field.—Sidney Paige examined the Lewis overthrust fault. A. A. Baker made an examination of the northward extension into Montana of the Sheridan coal field. He also mapped the geology and coal resources of several townships east of Tongue River and examined townships in northern Fergus County to determine their value as coal lands. A. J. Collier, in connection with the classification of possible oil lands, visited the McCue well, in Chouteau County, and the Bowes dome, Blaine County, and collected well data in the Kevin-Sunburst oil field. He also examined Judith River coals in an area south and west of the Fort Belknap Indian Reservation to obtain data for land classification. W. W. Rubey, M. N. Bramlette, and F. A. Melton, in a study of

The Cretaceous rocks that crop out around the Black Hills, did reconnaissance mapping in a strip from 6 to 18 miles wide along the southern border of the State from R. 52 E. to R. 62 E., in Powder River and Carter counties. T. W. Stanton and C. E. Dobbin, in company with W. W. Rubey, examined Cretaceous exposures in southern Carter County. J. T. Pardee mapped the glacial features in the Lincoln (Blackfoot) Valley, western Montana, and made reconnaissance examinations in the Beaverhead and Bighole River basins and in the Gallatin Valley. He also made a detailed examination of phosphate land near Philipsburg, examined several townships in the Madison Range, and made a geologic reconnaissance in Madison and Gallatin counties to bring up to date the work of D. Dale Condit on the Three Forks-Yellowstone Park area. C. D. Avery spent some time looking over the results of oil exploration at Baker, Glendive, and other places in eastern Montana. S. H. Cathcart continued work in the Jardine-Crevasse district. C. E. Dobbin studied the Fox Hills, Lance, Fort Union, and Wasatch formations in southeastern Montana and northeastern Wyoming.

Office.—Frank Reeves revised his paper on the structure of the Bearpaw Mountains, which was published in the American Journal of Science; wrote an article on the shallow folding and faulting in the Bearpaw faulted belt for the American Journal of Science; completed a report on the geology of the Cat Creek and Devils Basin oil fields and adjacent areas; and compiled map and illustrations for a general report on the Bearpaw Mountains. Frank Reeves and W. T. Thom, jr., compiled data on coal in Fergus and Blaine Counties for land classification. A. A. Baker prepared three reports on the northward extension of the Sheridan coal field, a short report on the oil prospects, a general report and individual township reports on the geology and coal resources for the land-classification branch, and a final report for publication on the geology and coal resources of the area. Mr. Baker also prepared coal-classification data for areas in Fergus County. K. C. Heald submitted a report on the Ingomar dome. W. W. Rubey, in connection with work on the Black Hills rim project, prepared land-classification data on some areas in southern Carter County. A paper on *Lithothamnium ellisianum*, n. sp., from the Ellis Jurassic formation of Montana, was written by M. I. Goldman and M. A. Howe for outside publication. J. T. Pardee prepared reports on the classification of phosphate lands in the Madison Range and Philipsburg areas. He is revising and bringing up to date the report of D. Dale Condit and Elmer Finch on the geography and geology of the Three Forks-Yellowstone Park area, Montana. The chapter on coal in western Montana was revised by W. T. Thom, jr. Mr. Thom and C. E. Dobbin assembled data for their report on coal in Garfield, McCone, and Richland counties. Mr. Thom also prepared an article on United States Geological Survey work in Montana for 1924, which was transmitted for publication in the annual oil edition of the Great Falls Leader. C. E. Dobbin compiled stratigraphic data on the Cretaceous-Eocene transition beds in Montana and Wyoming. S. H. Cathcart prepared a report on the Jardine-Crevasse district and revised his part of the report on the Little Rocky Mountains. R. S. Knappen completed a report on the geology and oil prospects of the northern part of the Big Horn Basin. G. H. Girty studied Carboniferous invertebrates of the State; J. B. Reeside, jr., reported on Jurassic and Cretaceous fossils collected by R. S. Knappen and by W. W. Rubey and party in the western Black Hills and adjoining areas. W. C. Alden completed a professional paper on the glacial geology and physiography of the plains of eastern Montana. C. S. Ross prepared a paper on nephelite-haüynite alnöite from Winnett, for publication in the American Journal of Science.

NEVADA

Field.—H. G. Ferguson and S. H. Cathcart, assisted by W. F. Foshag, James Mansfield, and H. H. Chen, continued work on the Tonopah and Hawthorne quadrangles, Nev. T. W. Stanton studied the Mesozoic of the Humboldt Range and in cooperation with Mr. Ferguson the Mesozoic of the Hawthorne and Tonopah quadrangles. L. G. Westgate and J. L. Gillson completed a study of the Pioche mining district. D. F. Hewett carried on field studies in the Ivanpah quadrangle, Nevada-California, completing the work in the northeast quarter and most of that in the northwest quarter. He conferred in the field with G. F. Loughlin, W. C. Mendenhall, and L. F. Noble and studied the geology of the Searchlight district.

Office.—D. F. Hewett continued the preparation of a report on the Goodsprings mining district. He also prepared a paper on supergene silica and jarosite in southern Nevada for the Petrologic Society. Edwin Kirk studied Devonian fossils collected by Mr. Hewett. He also studied Ordovician, Silurian, and Devonian fossils sent in by Mr. Westgate. L. G. Westgate and J. L. Gillson continued work on the Ploche report. Mr. Gillson wrote a paper for unofficial publication on the borate mineral szababekite, found in Ploche. S. H. Cathcart and H. G. Ferguson continued work on a report on the Hawthorne and Tonopah quadrangles. Mr. Ferguson prepared a paper on western Nevada ore deposits. T. W. Stanton reported on Cretaceous, Jurassic, and Triassic invertebrates, and Edwin Kirk reported on Cambrian and Ordovician fossils from the Tonopah and Hawthorne quadrangles. W. H. Dall reported on Neocene fossils for W. F. Foshag. F. H. Knowlton prepared a paper describing a new species of *Potamogeton* from the Esmeralda formation. G. H. Girty reported on Carboniferous and Triassic fossils from Nevada. C. R. Longwell submitted a report on the geology of the Muddy Mountains.

Publications.—Bulletins 750-E, 762.

NEW ENGLAND

Arthur Keith completed the manuscript for a handbook of New England geography and collected data pertaining to earthquakes in New England.

NEW MEXICO

Field.—N. H. Darton obtained data for the geologic map of New Mexico and with J. B. Reeside, jr., made a reconnaissance examination of the Permian of the Guadalupe Mountains of southeastern New Mexico and western Texas. F. L. Hess briefly examined uranium deposits in the White Signal district, south of Tyrone, pegmatites at Petaca and Harding, and a molybdenum deposit at Questa. H. G. Ferguson revisited Mogollon and did geologic field work. D. F. Hewett examined manganese deposits near Socorro. W. W. Boyer did field work in the Artesia oil district, examined coal outcrops in the Sierra Blanca and La Ventana coal fields, and examined geologic structure in the Bloomfield, Mesa, and Aztec districts, San Juan County, for land classification.

Office.—N. H. Darton prepared a new draft of the geologic map of New Mexico and transmitted the State topographic map on a scale of 1:100,000. He also revised his report on the "Red Beds" of New Mexico and prepared a report concerning the new topographic and geologic maps of New Mexico for presentation to the American Association for the Advancement of Science. G. W. Stose did some editorial work on the geologic map of the State. H. G. Ferguson completed his report on the Mogollon district. M. N. Short assisted on this report and did petrographic work on sulphide ores from Mogollon. W. W. Boyer prepared a report and map on the Artesia oil district for the land-classification and water-resources branches. Mr. Boyer and J. B. Reeside, jr., wrote a press notice, "Prospects for oil and gas in and near the Barker Creek dome, Colorado and New Mexico," and Mr. Boyer prepared land-classification data covering coal cases in that district. A short paper was prepared by F. L. Hess on oolites for W. T. Lee's monograph on the Carlsbad Caverns, to be published by the National Geographic Society. H. W. Hoots wrote a paper on the geology of a portion of western Texas and southeastern New Mexico, with special reference to salt and potash. G. H. Girty studied Carboniferous fossils and also the Lake Valley fossil fauna. Edwin Kirk prepared and revised Ordovician and Devonian faunal lists for N. H. Darton for use in publications on New Mexico. W. H. Dall reported on Pleistocene fossils.

Publications.—Professional Paper 134.

NEW YORK

Field.—L. M. Prindle studied talc deposits in the vicinity of Gouverneur. N. Y. Mrs. E. B. Knopf made a reconnaissance investigation of the pre-Cambrian and Paleozoic section on the north flank of the Fishkill Mountains and studied the Paleozoic sections near Poughkeepsie and between Brewster and Holmes.

Office.—L. M. Prindle worked on the Taconic geologic folio and studied talc deposits of New York. W. H. Dall reported on Pleistocene fossils from Long Island, and R. D. Mesler worked on collections of Ordovician fossils.

NORTH CAROLINA

Field.—Lands in Cherokee County, N. C., were examined by Charles Butts for the Forest Service. W. C. Mansfield studied the Great Lake well No. 2, about 5 miles west of Havelock, in cooperation with the State Survey. He also collected Tertiary fossils on Neuse and Trent rivers and in the vicinity of Croatan; Quaternary fossils 10 miles from Beaufort; and Tertiary fossils at Greenville, Tarboro, and Halifax. C. S. Ross in a general reconnaissance of metalliferous deposits of the eastern United States visited mines at Sparta and Kings Mountain.

Office.—C. S. Ross began a report on the Ore Knob copper mine. L. W. Stephenson began a paper on additions to the invertebrate fauna of the Upper Cretaceous of the Carolinas and prepared plate explanations and made minor revisions for L. C. Kellum's paper on the paleontology and stratigraphy of the Castle Hayne and Trent marls. W. C. Mansfield studied Quaternary and Tertiary fossils from North Carolina. E. W. Berry wrote a paper on Pleistocene plants from North Carolina for Survey publication.

NORTH DAKOTA

C. H. Dane analyzed field notes and maps of the New Salem lignite field, N. Dak., to determine the geologic structure of the Fort Union formation.

OHIO

Field.—E. F. Burchard visited several localities in Ohio in connection with Mineral Resources work on cement. E. O. Ulrich spent one day in southwestern Ohio with Professor Shideler and Doctor Austin, the local authorities on the Richmond formations and faunas, and visited a number of their best sections.

Office.—Frank Leverett brought his field notes on Ohio into harmony with the topographic maps that have appeared since the field examination was made. G. H. Girty reported on Carboniferous fossils.

OKLAHOMA

Field.—K. C. Heald, P. V. Roundy, and W. W. Rubey attended the Osage Indian oil-lease sales at Pawhuska, at the request of the Commissioner of Indian Affairs. The Director, W. C. Mendenhall, David White, W. T. Thom, jr., C. N. Gould, of the Oklahoma Geological Survey, and Frank Buttram, of the State Board of Regents, conferred in Tulsa relative to cooperative projects to be undertaken in Oklahoma. H. D. Miser conferred with Oklahoma geologists with reference to obtaining data for the geologic map of Oklahoma and, in company with other geologists, did geologic mapping near Okmulgee and Shawnee. W. T. Thom, jr., collected data for a subsurface structure map of the northeastern part of the State, addressed meetings of the Okmulgee Geological Society and the Tulsa Geological Society, reviewed the areal geology between Okmulgee and Weleetka with Okmulgee geologists, and visited the Cushing, Tonkawa, Braman, Blackwell, and Newkirk oil pools. Mr. Thom, assisted by A. M. Farrell, was in charge of the Survey exhibit at the International Petroleum Exposition in Tulsa. R. D. Mesler collected fossils in the vicinity of Marble City.

Office.—The compilation of the manuscript copy of the geologic map of Oklahoma was completed by H. D. Miser. This work was done through the cooperation of the United States Geological Survey, the geologists of Oklahoma represented by Sidney Powers, the oil companies of Oklahoma through the National Research Council, and the Oklahoma Geological Survey. Mr. Miser and M. G. Wilmarth read critically the manuscript of a report by C. N. Gould on the rock formations of Oklahoma, for publication by the State Survey. Mr. Miser prepared a note on the temperature of Oklahoma's deepest well for publication in the Bulletin of the American Association of Petroleum Geologists. W. T. Thom, jr., assisted by A. A. Baker, C. H. Dane, O. C. Postley, and A. M. Farrell, under the cooperative auspices of the Federal and State surveys, prepared a contour map showing the subsurface structure of northeastern Oklahoma. Mr. Thom presented a short paper on this map to the American Association of Petroleum Geologists and prepared one also for the Oklahoma Geological Survey. K. C. Heald compiled data on the Americus limestone of Kansas and the Foraker limestone of Oklahoma to aid in the determination of

their equivalency. Mr. Heald also wrote a report on oil lands in the Red River district, Oklahoma-Texas, and transmitted it to the land-classification branch. P. V. Roundy prepared data to be used in connection with the December sale of Osage leases and a report to the superintendent of the Osage Agency. He also examined well cuttings and outcrop material from Oklahoma. A. F. Melcher, under the direction of the National Research Council and in cooperation with the Oklahoma Geological Survey, studied pore space of Cromwell oil sands. H. D. Miser and C. S. Ross prepared an article on the volcanic rocks in the Upper Cretaceous of southeastern Oklahoma and southwestern Arkansas, for publication in the American Journal of Science, and began an official report on the same subject. C. E. Siebenthal prepared a descriptive circular accompanying a contour map of the surface of the beds underlying the Cherokee shale in a portion of the Picher district, showing the relation of ore bodies to the subsurface topography. G. H. Girty studied and reported on Carboniferous fossils, prepared reports on the Morrow and Wapahucka faunas, and continued work on a report on the Moorefield fauna and the Mayes and "sub-Batesville" faunas. W. H. Dall reported on fossils from the State.

Publications.—Bulletin 759: structure map of northeastern Oklahoma; Press Notice 1107, on contour map of the surface of the beds underlying the Cherokee shale in a portion of the Picher district.

OREGON

Field.—C. P. Ross examined the Cornucopia district, Wallowa Mountains, Oreg., for a report to be issued by the State.

Office.—C. P. Ross prepared data on the Cornucopia district for incorporation in a report to be issued by the State on the Wallowa Mountains region. He prepared a paper for publication in the Pan-American Geologist on Tertiary planation in eastern Oregon and central Idaho, and also one on the same subject for presentation to the American Association for the Advancement of Science.

PENNSYLVANIA

Field.—David White addressed the Board of Commerce of Bradford, Pa., and the oil operators of the region on the problems of the Bradford sand. A. F. Melcher procured samples of oil sands, collected data on production of oil wells producing from water drive, consulted with oil companies relative to the study of texture and production of the Bradford sand, and gave advice concerning the taking of diamond-drill cores through the Bradford sand. W. B. Lang, in connection with porosity studies, visited Bradford, Oil City, and Titusville. W. T. Thom, jr., and M. R. Campbell made a field trip to study semianthracite in Lykens Valley and collected samples for study, and Mr. Thom visited coal mines and oil and gas fields near Pittsburgh and Oil City. Charles Butts carried on geologic work in the Tyrone quadrangle. A. I. Jonas did some field work on the geologic structure in the McCall's Ferry quadrangle, collected data for the cooperative geologic State map, and collected economic data in Lancaster County. G. W. Stose made field investigations in the Allentown, Slatington, Doylestown, Quakertown, Boyertown, Reading, Lebanon, Lancaster, and Middleton quadrangles.

Office.—E. B. Knopf and A. I. Jonas completed the report on the geology of the Quarryville and McCall's Ferry quadrangles, and Miss Jonas prepared a report on the New Holland quadrangle which was transmitted to the State geologist. A. F. Melcher began a report on the study of the pore space of the Bradford oil sand. A press notice on the porosity of the Bradford oil sand near Custer and its relations to the production of oil was prepared by A. F. Melcher, W. W. Rubey, and A. A. Baker. Charles Butts revised the text of the Hollidaysburg-Huntington folio, which was transmitted for publication, and revised the map and text of the Bellefonte folio by E. S. Moore. He also began the preparation of a map and report on the Tyrone quadrangle. G. W. Stose and A. I. Jonas prepared a paper on the Triassic sediments and basaltic lava north of Lebanon for the Geological Society of America and for the American Association for the Advancement of Science. Mr. Stose also worked on the Paleozoic geology of the Quakertown and Doylestown quadrangles. Messrs. Stose and Butts and Miss Jonas worked on a cooperative revision of the geologic map of Pennsylvania by the Federal and State geological surveys. Mr. Stose revised the West Chester-Coatesville folio, of which

he is joint author with Florence Bascom. David White prepared a paper on the prehistoric fossils of Pennsylvania for the Pennsylvania State Forestry Association. G. H. Girty worked on a report on the Pocono fauna and studied collections of other Carboniferous fossils. Frank Leverett brought his field notes on Pennsylvania into harmony with the topographic maps that have appeared since the field work was carried on.

Publication.—Press Notice 1008, "The porosity of the Bradford oil sand near Custer City, Pa., and its relation to the production of oil."

PORTO RICO

G. R. Mansfield examined borings from the Guajataca reservoir, Porto Rico.

SOUTH CAROLINA

L. W. Stephenson began the preparation of a paper on additions to the invertebrate fauna of the Upper Cretaceous of the Carolinas. C. W. Cooke reviewed the mapping of Eocene-Cretaceous-crystalline boundaries in Aiken and Edgefield counties, S. C.

SOUTH DAKOTA

Field.—F. L. Hess examined gold-arsenic mines and pegmatite near Keystone, S. Dak., and in the Black Hills. T. W. Stanton, J. B. Reeside, jr., W. W. Rubey, M. N. Bramlette, and F. A. Melton made stratigraphic studies of the Cretaceous and Carboniferous rocks in the northern and eastern parts of the Black Hills and collected fossils.

Office.—K. C. Heald inspected and described drill cuttings from South Dakota. T. W. Stanton reported on Cretaceous invertebrates, and F. H. Knowlton on Lakota plants. G. H. Girty studied and reported on Carboniferous fossils from the State. J. B. Reeside, jr., reported on collections of fossils made by W. W. Rubey and party in the Cretaceous rocks of the Black Hills and adjoining areas.

Publications.—Bulletin 765, Geologic Folio 219.

TENNESSEE

Field.—E. F. Burchard examined iron ore deposits at Napier, Lewis County, Tenn. Charles Butts examined tracts of lands in Monroe County, for the Forest Service. C. S. Ross visited mines of the Tennessee Copper Co., Ocoee Copper Co., and Ducktown Copper, Sulphur & Iron Co., at Ducktown. E. W. Berry spent some time in field work on the Coastal Plain, in cooperation with the Tennessee Geological Survey.

Office.—E. F. Burchard completed a cooperative report on brown iron ores of the western Highland Rim, to be published by the Tennessee Geological Survey. G. H. Girty studied Carboniferous fossils, and E. W. Berry worked on collections of fossil plants from Tennessee. Charles Butts revised a report on the Crossville quadrangle for the State Geological Survey and prepared for the Forest Service a report on several tracts of forest land in Monroe County. H. D. Miser began a report on the Waynesboro quadrangle.

TEXAS

Field.—W. B. Lang continued field work in the potash area of western Texas, visiting wells that were being drilled and collecting samples of well cuttings. T. W. Stanton studied the Mesozoic of western Texas in company with Mr. Lang. W. C. Mendenhall spent 10 days with Mr. Lang and Mr. Stephenson. Julia Gardner made field studies of the Eocene formations north of Brazos River in connection with the preparation of her monograph on the Eocene of Texas. Her studies on the Midway formation are being made in cooperation with the Texas Bureau of Economic Geology and Technology. Miss Gardner also inspected fossil collections from Brazos County for the Agricultural and Mechanical College at College Station. L. W. Stephenson held conferences with petroleum geologists in Houston, Dallas, Austin, Corsicana, Greenville, Texarkana, and New Boston in connection with the compilation of the new cooperative geologic map of the State. Considerable field work was done in connection with this map. Mr. Stephenson did field work in connection with the preparation of a paper on the stratigraphy of the

Gulf (Upper Cretaceous) of the Texas Coastal Plain, and, with Sidney Powers, he examined Cretaceous outcrops at the Brooks salt dome, Smith County. N. H. Darton and J. B. Reeside, jr., made a reconnaissance to gather data pertaining to the Permian of the Guadalupe Mountains of southeastern New Mexico and western Texas. M. I. Goldman visited Houston and the Big Creek salt dome, Fort Bend County, in connection with his studies of salt-dome cap rocks. T. W. Stanton made a field study of the stratigraphy and paleontology of the Lower Cretaceous (Comanche series) in the high plains region from Sweetwater to Fort Stockton and from Lamesa to Sanderson, also in the southeastern part of the Burnet quadrangle. He held a conference at Austin with the geologists of the Bureau of Economic Geology and Technology.

Office.—L. W. Stephenson and N. H. Darton compiled data for the geologic map of Texas. M. I. Goldman made a laboratory study of salt-dome cap rocks. He wrote a paper on this subject for publication in the Bulletin of the American Association of Petroleum Geologists. K. C. Heald prepared a report on oil lands in the Red River district, Okla.-Tex., for transmission to the land-classification branch. H. D. Miser examined drill cuttings from a well at Silver City. Julia Gardner completed a paper on a new species of *Argyrotheca* from the Butler salt dome, determined fossils from the Eocene of northeast Texas, in this connection studying the Aldrich collection in Johns Hopkins University, and prepared a short paper on the fauna from the Midway of the Butler dome, Freestone County. M. N. Short made an investigation of potash salts from wells in Texas. G. R. Mansfield wrote a press notice on potash in the Cowden well, Crane County. W. B. Lang was in Washington for several months for conferences and studies relative to developments in the western Texas potash field. He submitted a paper for Survey publication on potash investigations in 1924. H. W. Hoots completed a paper on the geology of a portion of western Texas and southeastern New Mexico, with special reference to salt and potash. L. W. Stephenson read and revised portions of A. C. Trowbridge's report on the lower Rio Grande region, and Julia Gardner prepared illustrative material for the report. Mr. Stephenson made progress on a report on the stratigraphy of the Gulf series (Upper Cretaceous) of Texas. G. H. Girty studied the Hueco fauna of the Cornudas Mountains. P. V. Roundy studied outcrop material from Texas in connection with his studies in micro-paleontology. M. I. Goldman prepared a report on the petrography of the contact of the Ordovician and Mississippian in San Saba County in connection with the study of the paleontology of the Mississippian by G. H. Girty and P. V. Roundy.

Publication.—Map of oil and gas fields of Texas.

UTAH

Field.—E. M. Spieker, assisted by D. J. Fisher, continued the study of the Wasatch Plateau, Utah, mapping areas west and north of Huntington and Price, and on the completion of this work they began a study of the stratigraphy and structure of the northern part of the San Rafael Swell, giving special attention to oil possibilities. Later this work was continued by James Gilluly, assisted by D. J. Fisher, C. H. Dane, and E. T. McKnight. Mr. Spieker examined and classified for their phosphate content lands near Provo, and J. T. Pardee made similar examinations of several sections of land near Huntsville. J. B. Reeside, jr., studied several stratigraphic sections in the Wasatch Plateau region and the San Rafael Swell. D. J. Fisher began the examination of coal lands along the Book Cliffs southeast of Sunnyside. G. I. Finlay, assisted by C. H. Dane, completed a reconnaissance examination for land classification in the Four Corners area of Arizona and Utah. Mr. Dane examined the area immediately around Cisco. James Gilluly and Mr. Dane classified lands in several townships near Crescent. F. L. Hess spent a few days in field work on rare metals and, with V. C. Helkes, visited the arsenic deposits at Gold Hill. G. F. Loughlin also made a brief visit to this district with a view to a detailed survey of it in the future. Mr. Loughlin visited iron mines and gypsum quarries near Cedar City and examined potash prospects near Marysvale for land classification. F. E. Matthes accompanied the congressional subcommittee on appropriations for the Department of the Interior through Zion National Park. E. F. Burchard examined iron-ore deposits in the Iron Springs district. W. H. Bradley and C. E. Erdmann examined oil-shale lands in west-

ern Millard County, in Beaver County, and in the eastern part of the State for land classification. They also visited oil prospects in Beaver County and classified coal lands near Cedar City and Kanarraville. C. D. Avery visited the Chalk Creek, Spring Creek, and Coalville oil fields. W. C. Alden extended his study of glacial geology and physiography in southwestern Wyoming into northeastern Utah. T. B. Nolan worked in the Salduro Marsh for the purpose of delimiting potash leasing land in cooperation with the General Land Office and Bureau of Mines.

Office.—F. C. Calkins continued work on a report on the general geology of the Cottonwood district. H. D. Miser wrote a paper on erosion in San Juan Canyon, for presentation before the Geological Society of America, and it was also given at the joint meeting of the Washington Academy of Sciences and the Geological Society of Washington. E. M. Spieker revised his report on the Salina Canyon coal area, which was transmitted for publication. Mr. Spieker and A. A. Baker completed a report on the Wasatch coal field. A paper by Mr. Spieker and J. B. Reeside, jr., on Cretaceous and Tertiary formations of the Wasatch Plateau was completed for publication by the Geological Society of America. Messrs. Spieker and Baker completed for the land-classification branch a report and map covering the Horse Canyon district of the Book Cliffs coal field; also a report on phosphate in secs. 20, 21, 28, and 29, T. 7 S., R. 5 E., Salt Lake base and meridian. J. T. Pardee prepared a report on phosphate lands north of Salt Lake for the land-classification branch. James Gilluly, assisted by C. H. Dane, began a report on the San Rafael Swell and prepared a report on the northern part of this region for the land-classification branch. C. H. Dane and James Gilluly wrote a report on the Cisco dome and Crescent anticline. G. R. Mansfield prepared a report for the land-classification branch on two tracts of land for which patent was sought. He also spent some time in conferences with members of the Survey, Bureau of Mines, and General Land Office, to delimit leasing areas in the potash land in the Salduro Marsh. W. B. Lang's report on potash investigations in 1924 included a little information relative to potash investigations in Utah. G. H. Girty studied Carboniferous invertebrates. J. B. Reeside, jr., revised his report on the geology along Green River, Wyoming and Utah, for inclusion in a paper by R. R. Wooley for unofficial publication. He also studied collections of fossils made by E. M. Spieker and James Gilluly in the San Rafael Swell, examined and reported on Jurassic and Cretaceous fossils collected in southeastern Utah by H. E. Gregory, and compiled data on variations in Cretaceous sandstones in southern Utah for R. C. Moore. G. I. Finlay and C. H. Dane prepared a report on the Four Corners area, Arizona and Utah, for the land-classification branch. L. F. Noble wrote a paper on the section of the Kaibab Limestone at Buckskin Gulch. G. F. Loughlin prepared a land-classification report on alunite claims near Marysville.

Publication.—Bulletin 751-D.

VERMONT

Field.—Arthur Keith, with A. C. Swinnerton, did field work in the Castle-ton quadrangle, Vt. Mr. Keith also mapped the structure and stratigraphy in the St. Albans quadrangle. L. M. Prindle did field work in the Pawlet, Greylock, and Berlin quadrangles and studied talc deposits in the vicinity of Johnson, Waterbury, Rochester, and Chester. Messrs. Keith and Prindle studied the stratigraphy and structure of the Vermont slate belt and the Cambrian stratigraphy of northwestern Vermont.

Office.—Arthur Keith made a study of Vermont stratigraphy preparatory to field work. L. M. Prindle studied material bearing on the geology of the talc deposits of Vermont and New York and did some work on the Taconic geologic folio.

VIRGINIA

Field.—C. S. Ross visited a pyrite mine at Monerate, Va., in connection with the reconnaissance of metalliferous deposits of the eastern United States.

Office.—M. R. Campbell completed a cooperative report on the Valley coal fields of Virginia and transmitted it to the State geologist for publication. W. C. Mansfield continued work on a report on the Miocene stratigraphy of Virginia. He also began a paper on the climatic conditions indicated by the molluscan fauna of the Chesapeake group of Maryland and Virginia.

WASHINGTON

Field.—E. F. Burchard, accompanied by O. P. Jenkins, of the Washington Division of Geology, inspected iron-ore deposits in Washington.

Office.—F. H. Knowlton studied the fossil flora of the Puget group of Washington and began a report on this subject. He revised his manuscript on the flora of the Latah formation, and Edward Sampson prepared some notes on the volcanic rocks near Spokane, for incorporation in this report. J. T. Pardee and Kirk Bryan prepared a paper on the geology of the Latah formation in relation to the lavas of Columbia Plateau near Spokane, for presentation to the American Association for the Advancement of Science. F. C. Calkins made a petrographic study of cores from the Latah-Texas well for the Engineers' Club of Spokane. T. W. Stanton reported on Lower Cretaceous fossils and also on Triassic and Cretaceous invertebrates from San Juan, Spieden, and Sucia islands. W. H. Dall reported on Eocene fossils. F. E. Matthes revised a pamphlet on the glaciers of Mount Rainier, at the request of the National Park Service.

WEST VIRGINIA

G. H. Girty studied Carboniferous invertebrate fossils from West Virginia. Frank Leverett brought his field notes on West Virginia into harmony with the topographic maps that have appeared since the field work was carried on.

WISCONSIN

Field.—E. O. Ulrich did stratigraphic work on the Cambrian and younger rocks of south-central and western Wisconsin in cooperation with the State Survey.

Office.—Edwin Kirk prepared and studied for comparison with western Silurian faunas fossils furnished by E. O. Ulrich from the Mayville formation of Wisconsin.

WYOMING

Field.—W. W. Rubey, M. N. Bramlette, F. A. Melton, T. W. Stanton, J. B. Reeside, jr., and C. E. Dobbin collected and studied fossils from the Pennsylvanian and Cretaceous formations of the Black Hills in Wyoming, Montana, and South Dakota. Mr. Rubey mapped and measured stratigraphic sections in the Upper Cretaceous from Moorcroft north to the Montana State line and made further studies in the Rocky Ford oil district. Mr. Dobbin, assisted by H. F. Clark, made a reconnaissance reexamination of coal lands in the Gille (Upper Belle Fourche) and Pumpkin Butte coal fields, to obtain data for the revision of a report previously prepared by V. H. Barnett. Mr. Dobbin also studied recent coal-mine developments in the Hanna Basin, to revise a report by C. F. Bowen, and completed a study of the Fox Hills, Lance, Fort Union, and Wasatch formations in southeastern Montana and northwestern Wyoming. A. J. Collier, C. D. Avery, and E. T. McKnight determined the structure of the Strom and Rex Lake domes, in Albany County, and the Pass Creek, Little Valley, Hatfield, and Miller Hill domes, in Carbon County. Messrs. Collier and McKnight examined coal lands in southwestern Carbon County, mapped in some detail the structure of the Buffalo Basin anticline and the Crook Gap anticline, in Fremont County, and examined the Horsetrack and Pacific Springs anticlines, Fremont County, and the Lost Creek, Pickett Lake, and Wilmington anticlines, Sweetwater County. Mr. Avery collected oil-well data in the Big Piney, Labarge, and Fossil oil fields and at Cheyenne. T. W. Stanton and J. B. Reeside, jr., reviewed the Cretaceous and Tertiary sections at many localities near the Union Pacific Railroad from Black Buttes on the west to Rock River on the east. Mr. Stanton also accompanied C. E. Dobbin and W. W. Rubey during their review of the Cretaceous-Eocene transition formations in the Powder River basin. W. H. Bradley classified coal land in a township in Baxter Basin, south of Rock Springs. W. C. Alden made a study of the glacial geology and physiography of eastern Wyoming, including Laramie, Platte, Converse, Natrona, and Albany counties, and of western Wyoming from Jackson Hole and the Wind River Mountains south to Rock Springs. Edwin Kirk studied the Ordovician of the Wind River Range. J. T. Pardee examined phosphate lands in western Teton County.

Office.—Editorial work on the Wyoming geologic map was done by G. W. Stose. W. W. Rubey, W. T. Thom., jr., and C. E. Dobbin prepared corrections for the map. G. R. Mansfield wrote a report for the land-classification branch on phosphate lands in the Teton Basin. J. D. Sears completed his report on the geology of the Baxter Basin gas field, Sweetwater County. W. W. Rubey prepared a press notice concerning the Rocky Point-Stromer anticline, accompanied by a sketch structure map, and continued work on his report on the Rocky Ford oil district and also on a general report on the Black Hills Rim project. J. T. Pardee made land-classification reports on phosphate lands in western Teton County. J. B. Reeside, jr., revised his report on the geology along Green River, Wyoming and Utah, for inclusion in a paper by R. R. Wooley for unofficial publication. C. E. Dobbin completed a report on the Gillette coal field, of which he is a joint author with V. H. Barnett and which contains a chapter on the Minturn district by W. T. Thom, jr. Mr. Dobbin compiled stratigraphic data on the Cretaceous-Eocene transition beds in Wyoming and completed his part of a report on the Pumpkin Butte coal field, by C. H. Wegemann, R. W. Howell, and C. E. Dobbin. F. L. Hess prepared a report on the platinum deposits near Centennial, Albany County. W. C. Alden began a report on the glacial geology and physiography of Wyoming and submitted papers on this subject to the American Association for the Advancement of Science and the Geological Society of Washington. W. H. Bradley's report on shore phases of the Green River formation in northern Sweetwater County was completed. A. J. Collier wrote a press notice on Rex Lake and other domes west of Laramie; a press notice and a land-classification report on oil and gas prospects of the Miller Hill-Lake Valley anticline, Carbon County; a press notice on the gas field in Buffalo Basin, Fremont County; and reports on the Spring Creek dome and anticlines in the western part of the Great Divide Basin, Fremont and Sweetwater counties, and on a coal-prospecting permit in western Carbon County for the land-classification branch. D. F. Hewett revised his report on the geology and mineral resources of the Oregon Basin, Meeteetse, and Grass Creek Basin quadrangles, which was transmitted for publication. J. B. Eby prepared a press notice relative to the Baggs anticline, Sweetwater County. Edwin Kirk reported on Cambrian fossils and arranged Ordovician collections of fossils from the Lander region; G. H. Girty studied Carboniferous fossils from Yellowstone Park and the Black Hills; T. W. Stanton reported on Eocene invertebrates from Campbell County; W. H. Dall reported on Neocene fossils; F. H. Knowlton reported on fossil wood and plants from the Black Hills and from Buffalo Basin; and J. B. Reeside, jr., studied Cretaceous fossils collected at the Rex dome, examined collections of Jurassic and Cretaceous fossils from the western Black Hills and adjoining areas, and revised faunal lists for a paper on the Belle Fourche coal field by V. H. Barnett, made up a collection of Mesozoic fossils for exchange, and examined part of a collection of Cretaceous fossils from eastern Wyoming. W. T. Lee revised his report on the correlation of formations in eastern Colorado and central Wyoming, which was critically reviewed by H. D. Miser.

Publications.—Geologic map of Wyoming; Professional Paper 132-F; Bulletins 750, 751-G, 764; Press Notices 17915, on the Rocky Point plunging anticline; 1545, on the gas field in Buffalo Basin, Fremont County; 17875, on the Lost Soldier-Ferris district; 14, on the prospects for oil in the Rex Lake and other domes west of Laramie; 18092, on the prospects for oil or gas in an anticline near Baggs; and 483, on oil and gas in the Miller Hill-Lake Valley anticline, Carbon County.

OTHER COUNTRIES

T. W. Stanton reported on Cretaceous invertebrates from western Africa for C. F. Bowen. W. H. Dall reported on fossil material from western Africa for C. W. Washburne.

K. C. Heald tested bituminous limestone from the vicinity of Bir Ali, Arabia, at the request of the State Department.

J. B. Reeside, jr., studied and made a report on a collection of Cretaceous fossils from Argentina for F. H. Lahee; and W. H. Dall reported on Tertiary fossils for Prof. Bailey Willis.

F. L. Hess, with E. P. Henderson, prepared a paper for outside publication on polycrase from Brazil.

W. H. Dall reported on Tertiary fossils from British Columbia sent by the Victoria Colonial Museum, British Columbia; on fossiliferous material dredged off the Grand Banks and vicinity for the Peabody Museum, Yale University; and on petropods of the Canadian Arctic expedition sent by the Victoria Memorial Museum of Ottawa. E. O. Ulrich, assisted by R. D. Mesler, studied fossils obtained between the lowest Canadian graptolite zones and the top of what Mr. Ulrich proposes to call the Ozarkian zone in British Columbia, and T. W. Stanton prepared a report on some Cretaceous fossils from Alberta and examined Paleozoic fossils from British Columbia, for the Geological Survey of Canada.

Edwin Kirk wrote the first draft of a paper on a new Devonian pelecypod genus from China, and W. H. Dall reported on fossils from northeastern China.

J. B. Reeside, jr., prepared a report with illustrations on a collection of Cretaceous invertebrates from eastern Ecuador.

Edwin Kirk worked on a short paper on an old collection of fossils from Ellesmereland.

W. H. Dall reported on fossils from the Fiji Islands sent by the Marine Seminary at Brookland, D. C.; also on fossil collections from British Guiana, Japan, Mexico, Nicaragua, and the Island of Papua.

W. C. Mansfield prepared a preliminary report on Tertiary fossils from Panama.

R. D. Mesler worked up for comparison and for biologic study collections of fossils from Sweden made by E. O. Ulrich in 1922, and Mr. Ulrich studied these collections. W. H. Dall reported on fossils for the Swedish Natural History Museum.

W. H. Dall furnished data on fossils from Uruguay to Doctor Felippone, Montevideo, and on material sent by Dr. H. von Ihering.

W. H. Dall reported on fossils from the Dominican Republic sent by C. Maury, of Cornell University, also on fossil collections from Cuba and Trinidad and named a series of specimens from Watling Island. W. C. Mansfield corrected proof of his paper on the Miocene gastropods and scaphopods of Trinidad. W. P. Woodring prepared an article on *Arca patricia* Sowerby, a Miocene fossil from the Dominican Republic, for publication in Science; a paper on Quaternary reef caps of the Republic of Haiti, for presentation to the American Association for the Advancement of Science; and a paper on Miocene mollusks from Bowden, Jamaica, for the Carnegie Institution of Washington.

DIVISION OF MINERAL RESOURCES

The general organization of the division of mineral resources during the year was unchanged. J. P. Dunlop was transferred to the field May 1, 1925, with headquarters at Joplin, Mo. The clerical staff was reduced by four transfers and one resignation. During the year the division employed eight clerks on temporary appointments in the Washington office and one in the San Francisco office.

Cooperation with the State geological surveys of Alabama, Florida, Georgia, Illinois, Iowa, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Virginia, Washington, and Wisconsin was continued during the year. Cooperation with other Federal bureaus included the furnishing of some statistical data to the Bureau of Mines and the completion for the Bureau of the Census of work in connection with the canvass of consumption of mine timber and the census of manufactures from the previous year. Contact with other Government agencies was maintained through the regular attendance of the Survey's representative on the Economic Liaison Committee.

The metals section limited its work chiefly to the routine of collecting and publishing statistical matter relating to the mine, smelter, and refinery output of metals and to performing a small amount of

work in cooperation with the Senate Commission on Gold and Silver Inquiry. The nonmetals section was also engaged almost entirely in routine statistical inquiries and compilations. The coal section, in addition to compiling the annual statistical reports, prepared and issued a weekly report on coal and coke, maintained contact with the Department of Commerce in its studies of special features of the coal industry, and prepared reports on the commercial stocks of coal September 1, 1924, in cooperation with the Bureau of the Census, and June 1, 1925, independently. The work of the inter-departmental committee on coal statistics was completed early in December, and its report was placed in the hands of the Secretaries of Interior, Commerce, and Labor, through the heads of the bureaus interested. At the request of the American Statistical Association, a paper entitled "Mineral resources for the future population" was written by F. G. Tryon and Miss Lida Mann and read before the Association December 29. The coal section also prepared for the printer the manuscript of the report of the United States Coal Commission. The petroleum and natural gas section, besides preparing its routine annual and monthly statements on petroleum, compiled for the Federal Oil Conservation Board tables showing supply and demand for crude petroleum in 1920-1924, issued a map of the oil and gas fields of Texas, and began to compile new oil and gas maps of Oklahoma and Wyoming. The section of foreign mineral reserves was engaged chiefly in completing a world atlas on fuel reserves and in collecting and compiling information on the production of minerals in foreign countries.

In the San Francisco office the demand for statistical work required all the time of the geologist in charge, J. M. Hill, and necessitated the employment of additional temporary clerical help for about two and one-half months. Mr. Hill also began a geologic report on the Randsburg district and prepared a statement on the effects of the drought on placer mining in California in 1924. V. C. Heikes, statistician in charge of the Salt Lake City office, devoted most of his time to routine work. He also functioned as the Survey's specialist on arsenic and contributed to interbureau and interdepartmental discussion of the arsenic situation. C. N. Gerry, of the Salt Lake City office, devoted some time, both in the field and in the office, to the work of collecting old production records for the Wood River district, Idaho, from 1881 to 1906 as an aid to geologic study of metalliferous resources and as a beginning of a history of mining in Idaho. C. W. Henderson, in charge of the Denver office, besides directing the regular annual statistical inquiries, devoted a large part of his time to liaison work between the Survey and cooperating State officers of the Colorado Metal Mines Fund. He also completed revision and proof reading of his professional paper on the history of mining in Colorado.

The final proof of Parts I and II of Mineral Resources of the United States for 1922 has been sent to the Government Printing Office. Of the report for 1923, 58 chapters had been published at the end of the year, 1 was transmitted in June, and 3 are still in preparation. The preliminary summary of mineral production in 1924 was transmitted by the division March 31, and final page proof was

received May 23 and retransmitted June 27. Two chapters for 1924 have been published.

After the promulgation of the Executive order of June 4 transferring the division of mineral resources to the Department of Commerce arrangements for the transfer were perfected so that the division could be incorporated on July 1 as a part of the Bureau of Mines without interruption of work.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH

The personnel of the division of chemical and physical research on July 1, 1924, consisted of 7 chemists, 2 physicists, 2 laboratory aids, 1 clerk, 1 laboratory assistant, and 1 laborer. George Steiger was in charge of the division and supervised the work of the chemical laboratory, and C. E. Van Orstrand supervised the work of the physical laboratory. A. F. Melcher, geophysicist, resigned February 28, 1925, and P. G. Nutting was appointed March 16 to fill the vacancy. The most important change in the personnel of the division came through the retirement of F. W. Clarke December 31, 1924. Professor Clarke had been connected with the chemical work of the Geological Survey since 1883, and for 33 years of that time he was chief chemist. The outstanding feature of his work was his ability to marshal chemical data so that they could be readily used by the geologist. He is probably best known for his researches into the composition of the natural silicates and the general composition of the earth's crust, for his gathering from an enormous volume of literature in many languages the essential facts of geochemistry and putting them together in related form in a book that has run into several editions, for his tabulation of data on the constants of nature, and for his philosophical speculations regarding the chemical composition and physical condition of the earth's interior.

The funds available for chemical and physical work consisted of an appropriation of \$40,000 plus \$3,817 from the appropriation for salaries, less \$3,850 expended in the search for potash in the desert region of the Southwest.

WORK IN CHEMISTRY

For the official work of the Survey 1,077 quantitative analyses were made and 209 mineral specimens were examined and the minerals determined. The determinations including a careful study of their properties. In addition 3,191 specimens sent to the Survey by outside persons were identified. On June 30, 1925, 434 samples were awaiting quantitative analysis and 19 specimens awaiting identification.

F. W. Clarke read final proof of his two publications, "The data of geochemistry" and "The composition of river and lake waters of the United States."

W. T. Schaller made a field study of the lithium minerals and of an unusually deep pink muscovite in New Mexico and, with the assistance of E. S. Larsen, an exhaustive field study of the lithium pegmatites of southern California. Mr. Schaller read a paper before the National Academy of Sciences and prepared an article for publication on the origin of lithium pegmatites of California. He investigated the field relations of the new silver ore argent jarosite at Dividend, Utah, and studied the hydration of autunite.

R. C. Wells continued the study of the formation of metallic ores, prepared a paper on the reactions between ferrous salts and cuprous salts, which appeared in the American Journal of Science, wrote a book review for the

Journal of the American Chemical Society, and served as a member of the National Research Council's committee on the determination of geologic time. He also made tests for rare elements in numerous samples of petroleum coke and prepared a preliminary note, "Observations on the minor constituents of petroleum," which was published in *Economic Geology*.

George Steiger prepared a report of the work done during the year in the chemical analysis of sedimentary deposits for the committee on sedimentation of the National Research Council and served as a member of that committee. He also wrote a supplemental chapter for the treatise on sedimentation which is being compiled by W. H. Twenhofel.

E. T. Erickson made an investigation of part of a cargo of fish from a vessel that had been sunk in sea water for three years, which showed that organic compounds had been formed that yielded petroleum products upon simple distillation. This work was the basis of a paper prepared for publication by E. T. Erickson entitled "Geochemical relationships of animal life and organic matter in marine sediments as a source of petroleum." He also wrote a paper describing the chemical nature of ichthyol and continued his experimental work on the Green River oil shale.

R. K. Bailey made analyses of salts from a number of new wells that indicate that the area in which potash salts that compare favorably with those found in European deposits may occur is much larger than had been previously known. One of the most promising of these wells is in the southeastern part of Crane County, Tex. The potash-rich strata encountered in this well lie closer to the surface than those found in any of the other wells so far examined. Salts taken from the 894-foot level contained 6.24 per cent of potash (K_2O); other potash-rich strata occur at the 945 and 1,065 foot levels. A sample of carnallite containing the equivalent of 16.7 per cent of K_2O was received in the laboratory and said to have come from the Crescent Eagle well, near Thompson, Utah. It was reported that a very large quantity of the salt was taken from this well at the 3,150-foot level. A salt said to have come from the same well at 3,910 to 3,917 feet contained the equivalent of 49.05 per cent of K_2O . Mr. Bailey analyzed during May and June 70 samples from the Salduro Marsh region, Utah, as an aid to the classification of the land for its potash content.

E. P. Henderson spent most of his time in identifying mineral specimens for the general public.

J. G. Fairchild made analyses of two series of phosphate rocks for land classification, one from Montana and the other from Florida, made numerous quantitative analyses for geologists, and analyzed a series of samples of sediments taken from the bottom of the Atlantic Ocean between Maine and the Bahamas.

WORK IN PHYSICS

The application of physics in the study of geologic problems is being recognized as of fundamental importance in the fields of both theoretical and economic geology. Survey physicists are conducting researches in only a very few of the fields that are available for investigation.

Prior to his resignation A. F. Melcher made a special study of the porosity of the Bradford oil sand. Determinations on a core of the sand obtained near Chester City, Pa., showed a porosity of about 15 per cent between the depths of 1,238 and 1,282 feet. The results were summarized in a press notice on the porosity of the sand and its relation to the production of oil. Working under the direction of Mr. Melcher and the National Research Council, G. H. Hanson made a special study of the porosity of the cap rock in the Cromwell field, Okla.

P. G. Nutting continued the work of Mr. Melcher on the structure of oil sand in its relation to oil storage, migration, and recovery and prepared a paper entitled "Forces in the system oil-water-sand," dealing chiefly with the displacement of petroleum from oil sands by means of water and water solutions. A solution has been found that is inexpensive and in the laboratory gives a very clean, rapid drive of certain types of petroleum from oil sands. Further work is being done on methods of driving applicable to conditions existing in the Ohio, Oklahoma, and Texas oil fields.

C. R. Randall assisted in the routine observations and computations involved in the laboratory work until January 1, when he was transferred to the Bureau of Standards.

C. E. Van Orstrand cooperated with G. B. Richardson in the computation of petroleum production curves. The results of the computations are given in Mr. Richardson's paper, "Ratio of peak production to estimated total production in certain oil fields," and the theory involved was published in a paper on the empirical representation of certain production curves by Mr. Van Orstrand. Two reports were prepared for Prof. W. H. Twenhofel, chairman of the committee on sedimentation of the National Research Council, entitled "Some recent contributions by physicists that have a bearing on problems of sedimentation" and "Note on a possible method of representing the distribution of diameters of grains of sand." A short paper incidental to the work of the laboratory was published under the title "Note on certain practical problems which require the use of extended values of mathematical functions." Mr. Van Orstrand made temperature tests in deep well No. 1842 of the Peoples Natural Gas Co., near Long Bridge, Westmoreland County, Pa. This well has reached a depth of more than 7,700 feet and is the deepest well in the world. Temperature tests made by him in the oil fields at Coalinga, Calif., and Warm Springs, Ferris Dome, Lost Soldier, and Salt Creek, Wyo., point to the important conclusion that the highest temperatures in these fields are found at or near the crests of the anticlines. W. T. Thom, jr., has made a special study of the Salt Creek data in his paper, "The relations of earth temperature to anticlinal folds," and has emphasized the importance of utilizing temperature tests in prospecting for oil and other mineral deposits.

Advice and assistance were given to Gordon Taylor on the modification of the Nutting portable seismometer for field work in locating geologic structural features.

ALASKAN BRANCH

PERSONNEL AND EXPENDITURES

On July 1, 1924, the personnel of the Alaskan branch consisted of 1 chief Alaskan geologist, 6 geologists, 3 associate geologists, 1 junior geologist, 4 topographic engineers, 1 assistant topographer, 1 draftsman, and 3 clerks; on June 30, 1925, it consisted of 1 chief Alaskan geologist, 4 geologists, 3 associate geologists, 1 assistant geologist, 3 topographic engineers, 1 draftsman, and 2 clerks.

The funds available for the fiscal year 1925 included an appropriation of \$75,000 for the investigation of Alaskan mineral resources, carried in the Interior Department bill, available June 5, 1924, and \$72,000, carried in the Interior Department appropriation act for the year 1926, available March 3, 1925. In addition, funds amounting to \$75,000 were made available to the Survey by transfer from the Navy Department for the continuation of the investigation of Naval Petroleum Reserve No. 4, in northern Alaska. Two of these appropriations were legally available and expended during the fiscal year 1924; all three were available for expenses during the fiscal year 1925; and the balances of the Navy funds and the regular 1926 appropriation are available for expenditures during the fiscal year 1926. An allotment of \$3,800 was made available in the early part of the season of 1924 for the classification of Alaska public lands and was devoted to surveys of petroleum lands. The amount expended in starting field parties in advance of the beginning of the fiscal year in the field season 1924 practically offset the amount used to start parties at the end of the fiscal year 1925 to begin work for the field season 1925; and except for the work for the Navy Department the funds used for the fiscal year were about \$75,000.

The following table shows the approximate allotment for salaries and field and office expenses for the fiscal year 1925:

*Expenditures from funds directly appropriated for Survey
Alaska work*

Branch administration.....	\$3, 850
Other technical salaries.....	21, 750
Branch clerical and drafting salaries.....	5, 400
Services rendered by other Survey units, including editing, office duplicating-machine service, accounting, etc....	7, 000
Office expenses, stationery, telegrams, photography, etc....	2, 000
Field expenses.....	28, 000
Airplane mapping by Navy Department.....	7, 000
	<hr/> 75, 000

The items in the table for "Other technical salaries," "Field expenses," and "Airplane mapping" and \$1,500 of the item for clerical salaries have been allotted for the different kinds of surveys and investigations in progress during the fiscal year 1925, as follows:

General investigations.....	\$3, 750
Geologic surveys.....	33, 400
Topographic surveys.....	19, 150
Statistics of mineral production.....	1, 950
	<hr/> 58, 250

In the foregoing table it has been impossible to determine accurately the distribution of expense between geologic and topographic surveys, for two parties were engaged in work of both kinds.

*Proximate distribution of work by geographic divisions for the fiscal year
1925*

General investigations.....	\$3, 750
Southeastern Alaska.....	16, 750
Prince William Sound.....	8, 300
Matanuska region.....	5, 150
Southwestern Alaska.....	9, 775
McKinley region.....	3, 150
Nixon Fork region.....	6, 800
Upper Yukon.....	2, 625
Statistics of mineral production (including \$1,500 for clerical salaries).....	1, 950
	<hr/> 58, 250

An analysis of the \$75,000 transferred to the Geological Survey the Department of the Navy is as follows:

*Location of funds for surveys in Naval Petroleum Reserve No. 4, northern
Alaska*

Administration.....	\$2, 500
Other technical salaries.....	17, 100
Clerical and drafting salaries.....	3, 300
Services rendered by other Survey units, including editing, accounting, instruments, etc.....	2, 900
Office expenses, including stationery, photography, telegrams, etc.....	900
Field expenses.....	36, 000
Allotted to work in progress for fiscal year, 1926.....	11, 000
Balance for contingencies.....	1, 300
	<hr/> 75, 000

Areas surveyed by Geological Survey in Alaska, 1898-1925, in square miles

Fiscal year	Areas covered by geologic surveys			Areas covered by topographic surveys		
	Exploratory (scale 1:625,000 or 1:1,000,000)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500)	Exploratory (scale 1:625,000 or 1:1,000,000)	Reconnaissance (scale 1:250,000; or 200-foot contours)	Detailed (scale 1:62,500; or 25, 50, or 100-foot contours)
1898-1924.....	73, 200	123, 665	5, 657	51, 680	163, 430	3, 980
1925.....	4, 300	18, 590	190	4, 300	17, 470	130
	77, 500	142, 255	5, 847	55, 980	180, 900	4, 080
Percentage of total area of Alaska.....	39			41		

WORK OF THE YEAR

The heading "General investigations" in the preceding tables comprises a study of the broader aspects of the general geologic history of Alaska, to which several detailed investigations have contributed and in the course of which Alfred H. Brooks, who carried on this work, visited southeastern Alaska, Prince William Sound, and the country adjacent to the Alaska Railroad; an office study of the fossil flora of the Tertiary rocks of Alaska, to which Arthur Hollick devoted about three months; paleontologic studies which, through the courtesy of the geologic branch, were carried on mainly by the specialists of that branch and which were of importance in investigating and correctly interpreting certain coal and mineral deposits; additional work by James McCormick on revision of the "Geographic dictionary of Alaska," a valuable report published in 1906 which has been out of stock for many years; and petrographic study of some rocks and mineral specimens from Alaska by M. M. Short, of the geologic branch.

Among the paleontologic studies referred to above may be mentioned the determination by T. W. Stanton of invertebrate fossils from Mesozoic rocks collected by various parties in different parts of Alaska, the determination of F. H. Knowlton of Mesozoic plants, by Edwin Kirk of Ordovician, Silurian and Devonian invertebrates, by G. H. Girty of Carboniferous invertebrates by J. B. Reeside, jr., of fossils from Prince William Sound, and by W. H. Dall of Tertiary invertebrates.

The publications of the year consisted of a report on the progress of investigations in Alaska in 1922 (Bulletin 755), a report on the Point Barrow region, northern Alaska (Bulletin 772), a report on the Aniakchak Crater, Alaska Peninsula (Professional Paper 132-J), three chapters of the report on progress of investigations in Alaska in 1923 (Bulletins 773-A to 773-C), topographic maps covering parts of the Alaska Railroad route, and a revised edition of the base map of Alaska. Brief notices of these publications appear elsewhere in this volume.

Eleven parties, including 11 geologists, 4 topographic engineers, 1 topographic aid, and 25 auxiliaries, were dispatched to Alaska in 1924. Of these parties 6 were engaged in purely geologic work, 1 in purely topographic work, and 4 in combined geologic and topographic work.

Alfred H. Brooks, chief Alaskan geologist, died suddenly November 2, 1924; S. R. Capps served as acting chief Alaskan geologist until April 3, 1925, when Philip S. Smith was designated to take charge of the branch. Miss Lucy M. Graves devoted most of her time to administering the clerical work and was in charge of the branch during the absence of the chief and the senior Alaskan geologists. Miss Erma C. Nichols devoted about two-thirds of her time to the collection and coordination of the mineral statistics of Alaska.

Five projects were undertaken in southeastern Alaska, two of which were executed during the field season of 1924 and the others during the field season of 1925. In 1924 A. F. Buddington continued studies of the geology and mineral resources of the Ketchikan and Wrangell regions and collected much new

information regarding the general geology of southeastern Alaska in relation to the ore deposits.

In the same year R. M. Wilson continued detailed topographic mapping of the Hyder district, which had been started during the preceding fiscal year by E. S. Rickard, who had been injured in the course of field duty.

In 1925 Mr. Buddington was detailed to map the geology of unsurveyed areas in the southwestern part of the Ketchikan region and then to make detailed geologic surveys in the Hyder district.

R. K. Lynt in 1925 did topographic mapping in the Ketchikan district and then joined surveyors from the General Land Office to make a detailed topographic map in the vicinity of Wrangell Narrows.

Arrangements have been made with the Bureau of Aeronautics of the Navy Department for airplane photographing of the islands of southeastern Alaska, with a view to expediting topographic mapping and facilitating determination of the geology and mineral resources of probably 18,000 square miles of territory that is difficult to survey by other methods. The Alaskan branch allotted \$7,000 for this work, under the fortifications act, and the work will be done by the Navy Department as soon as preparations can be completed.

In the Prince William Sound region F. H. Moffit continued during the field seasons of 1924 and 1925 a study of the ore deposits and related geology of the western part of the sound and investigated mining developments in portions of the Copper River basin.

S. R. Capps, with K. K. Landes as geologic assistant, spent the field season of 1924 in the upper Matanuska region, mapping and determining the geologic history of the coal-bearing rocks. Late in the fiscal year, in the spring of 1925, Mr. Landes was assigned to complete the mapping of an area between Matanuska and Knik rivers.

W. R. Smith, during the field season of 1924, carried on geologic mapping in the Cold Bay region, where indications favorable for the accumulation of oil pools have been reported. In 1925 he left Washington to serve as geologist in explorations in Naval Petroleum Reserve No. 4.

In 1924 R. H. Sargent, with J. S. Brown, geologist, made topographic and geologic surveys in the Nixon Fork region of the Kuskokwim. In the field season of 1925 Mr. Sargent, with R. S. Knappen, geologist, conducted surveys westward from Cold Bay to Chignik, Alaska Peninsula.

A party in charge of S. R. Capps, in the field season of 1925, made geologic surveys in the country adjacent to Mount McKinley and investigated the mineral resources of portions of the Kantishna and Chulitna districts.

J. B. Mertie, jr., for all of the fiscal year until April, 1925, was engaged in work connected with surveys of Naval Petroleum Reserve No. 4. In May, 1925, he left Washington to conduct geologic investigations along Yukon River near the international boundary and to correlate previous geologic investigations in this region.

All the above-described projects that were started late in the fiscal year will be continued into the fiscal year 1926.

Geologic and topographic surveys made in Naval Petroleum Reserve No. 4 for the Department of the Navy were continued in 1924 by the dispatch in January of two parties, in charge of Philip S. Smith, with J. B. Mertie, jr., geologist, and Gerald FitzGerald and R. K. Lynt, topographers. These parties went overland and carried on surveys in unmapped areas in the southern and eastern parts of the reserve. During the open season of 1924 W. T. Foran, geologist, and O. L. Wix, topographer, went by sea to Wainwright and surveyed a strip of country in the western and southern parts of the reserve. All these parties returned to Washington in the fall.

In February, 1925, a party in charge of Gerald FitzGerald, topographer, with W. R. Smith, geologist, was sent into the southern part of the reserve north of Noatak River to make topographic and geologic surveys.

FUTURE WORK

Systematic investigations of the geology and mineral resources of Alaska have been carried on for more than a quarter of a century. Practically all this work was organized, administered, and largely participated in by Alfred H. Brooks, late chief Alaskan geologist, who, through his understanding of the problems of the mineral industry in a frontier country and broad technical knowledge was responsible for the application of sound scientific principles to the development

of the Territory's mineral resources. Although the work of the Geologic Survey in Alaska has been instrumental in furnishing a basis on which mineral and other industries might proceed with assurance as to soundness of the information furnished, it has covered only a little more than a third of the Territory with maps and reports that are at least of exploratory standard. Of the remaining 350,000 square miles, nearly 200,000 should be surveyed soon as funds and personnel are available. Areas that are of special importance at this time are southeastern Alaska, which, in addition to containing minerals of commercial value, contains enormous water-power resources that will be of value in developing the mineral and forest product industries in the general vicinity of the Alaska Railroad, the development of resources of which should contribute directly or indirectly to the success of Government enterprise; and a belt of mountain area from 100 to 200 miles wide, stretching from the international boundary to the Arctic Ocean on the west, which is largely unsurveyed and in which there are indications of valuable mineral deposits. There is also need for comprehensive studies and reports on the larger problems relating to the different mineral resources of the Territory, as well as for compilation and correlation of all available geologic information relative to southeastern Alaska; and the accumulation of data regarding much of the Territory has now reached a stage where compilation of a general geologic map of Alaska is warranted.

TOPOGRAPHIC BRANCH

ORGANIZATION

The organization of the topographic branch at the end of the year is shown below. The Rocky Mountain division was abolished December 31, 1924, and the limits of the Atlantic, Central, and Pacific divisions are shown on Plate I.

Chief topographic engineer, C. H. Birdseye.

Atlantic division, division engineer in charge, Glenn S. Smith. (In absence of Mr. Birdseye Mr. Smith acted as chief topographic engineer.)

Central division, division engineer in charge, W. H. Herron.

Pacific division, division engineer in charge, T. G. Gerdline.

Computing section, engineer in charge, E. M. Douglas.

Section of inspection and editing, engineer in charge, W. M. Beaman.

Section of cartography, engineer in charge, A. F. Hassan.

Map information office, engineer in charge, J. H. Wheat.

Section of relief maps, engineer in charge, J. H. Renshaw.

Section of photographic mapping, engineer in charge, T. P. Pendleton.

PERSONNEL

The technical force was increased by the appointment of 6 junior engineers, 18 apprentice engineering field aids, 1 senior photographer and 1 minor map printer, and the reinstatement or transfer of 4 associate engineers, 1 assistant engineer, and 1 chief engineering field aid. In addition, 1 technical field assistant was employed. The force was reduced by 1 death, 27 resignations, 1 transfer, and 4 retirements. With these changes the corps now includes 1 chief topographic engineer, 3 senior engineers in charge of divisions, 13 junior engineers, 69 associate engineers, 22 assistant engineers, 17 junior engineers, 16 chief engineering field aids, 11 senior engineering field aids, 2 assistant engineering field aids, 19 apprentice engineering field aids, 1 senior photographer, 14 engineering draftsmen of various grades, and 1 field assistant, a total of 189. During the year 1 associate engineer, 4 assistant engineers, 8 junior engineers, 2 chief engineering field aids, 7 senior engineering field aids, 2 assistant engineering field aids, and 17 apprentice engineering field aids were furloughed for the whole or a part of the year. The clerical force

comprises 16 clerks of various grades, one of whom is a per diem employee, and 1 messenger.

At the end of the year J. H. Renshawe, engineer in charge of the section of relief maps, was retired on account of age. Mr. Renshawe was one of the original members of the Survey, having been appointed July 8, 1879. His work on relief maps was unique and set a new standard.

PUBLICATIONS

The published work of the topographic branch for the fiscal year consisted of 75 new standard topographic maps, 4 new editions of topographic maps, 42 river plans and profiles, 1 contour State map (New Mexico), 1 new edition of a State map (Wyoming), 1 sheet of standard map symbols (Board of Surveys and Maps), advance photolithographic prints of 93 new topographic maps now in process of engraving, and 88 photolithographs of new topographic maps for which publication has not yet been otherwise provided. Additional publications were shaded relief editions of standard topographic maps of 2 quadrangles in Pennsylvania and 2 in West Virginia.

Bulletin 766, giving the results of spirit leveling in California, was published in 54 separate parts during the year. Parts B, Triangulation, and C, Traverse, of a new bulletin to be entitled "Topographic instructions of the United States Geological Survey" were transmitted for publication.

APPROPRIATIONS

The Federal appropriations for topographic surveys for the fiscal year 1925 were as follows:

Topographic surveys.....	\$500,000.00
Salaries, scientific assistants.....	11,108.33
Special funds for military mapping (contributed by War Department).....	14,975.99
	<hr/> 526,084.32

COOPERATION

Cooperation has been maintained in 21 States and 1 Territory, which contributed the following amounts:

Alabama.....	\$9,393.21	Oregon.....	\$4,192.88
California.....	78,113.21	Pennsylvania.....	33,563.87
Colorado.....	9,511.27	Tennessee.....	4,225.31
Connecticut.....	500.00	Texas.....	95,646.26
Hawaii.....	19,463.08	Utah.....	9,534.19
Illinois.....	47,843.11	Vermont.....	2,471.48
Iowa.....	1,299.43	Virginia.....	11,175.50
Kentucky.....	4,350.96	Washington.....	4,828.95
Maine.....	4,997.69	West Virginia.....	4,996.04
Missouri.....	24,470.51	Wisconsin.....	14,443.10
New Hampshire.....	12,970.48		
New York.....	14,945.46		<hr/> 412,935.99

In addition, base-map work was executed for other Federal organizations at the following cost: For the Appalachian Park Commission, \$231.50; for the General Land Office, \$53.33; for the National Park Service, \$849.78; for the Federal Board of Vocational Education, \$41.66—a total of \$1,176.27.

The total amount expended from all sources for the work of the topographic branch was \$940,196.58.

SUMMARY OF RESULTS

The condition of topographic surveys to June 30, 1925, distinguished as to scale and date, is shown on Plate I.

As shown in the following table, the new area mapped was 17,322 square miles, making the total area surveyed to date in the continental United States, exclusive of Alaska, 1,265,385 square miles or 41.8 per cent of the entire country. In addition, 481 square miles of resurvey was completed, making a total of 17,803 square miles. River surveys were completed during the year 17,852 square miles. River surveys of 857 linear miles were also made.

In connection with these surveys 7,128 linear levels were run, making 312,103 miles of primary levels. Since the authorization of this work by Congress, 1,860 permanent bench marks have been established.

Triangulation stations to the number of 113 were established and were permanently marked.

Primary traverse lines aggregating 4,429 miles were run in connection with which 1,109 permanent marks were established.

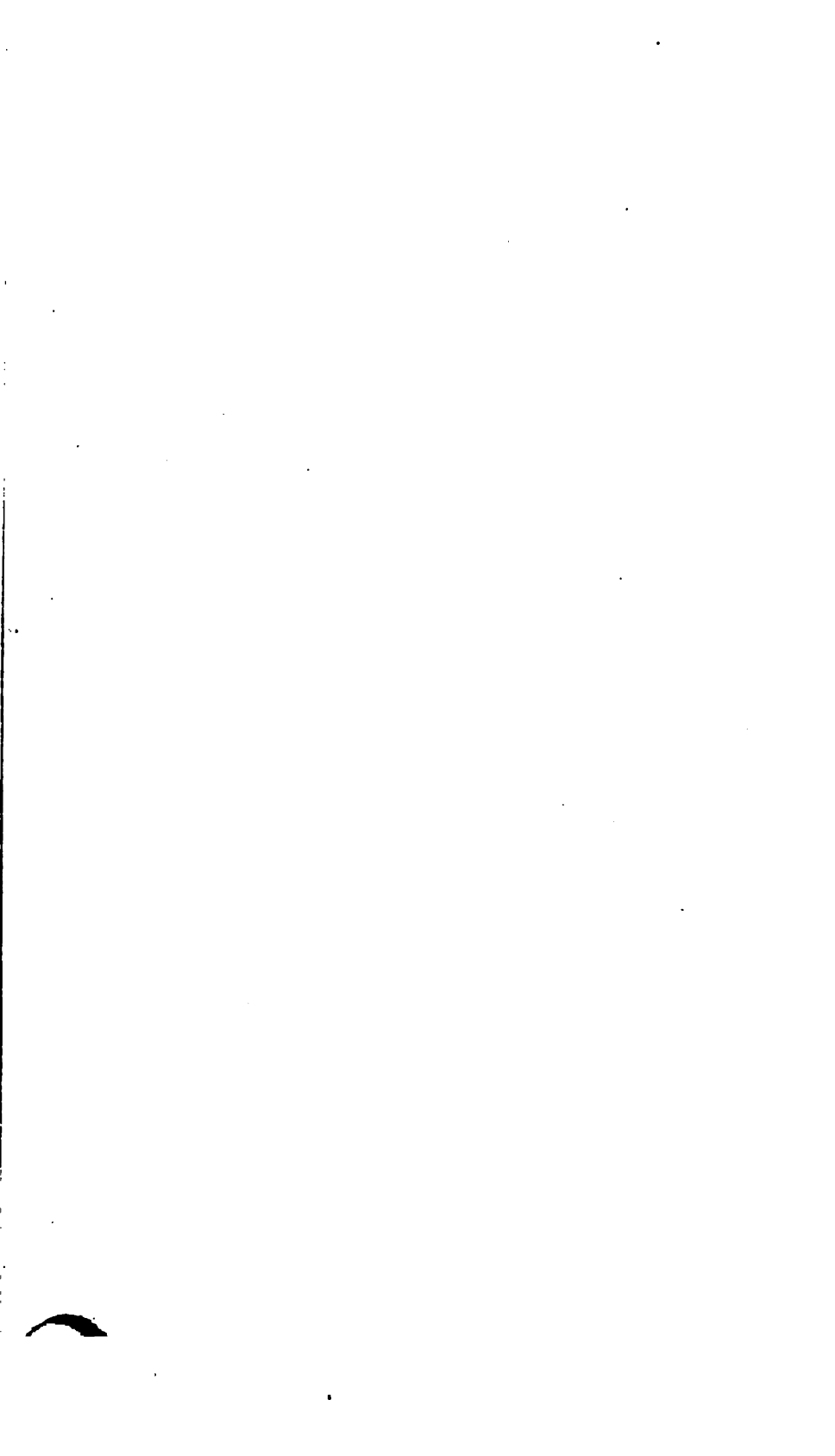
In addition, 481 square miles of topographic maps were completed in Hawaii, and 42 miles of primary levels were run. Permanent bench marks established.

Present condition of topographic surveys of the United States, surveyed July 1, 1924, to June 30, 1925

State	New area mapped July 1, 1924, to June 30, 1925	Total area mapped to June 30, 1925	Percent- age of total area of State mapped to June 30, 1925	State	New area mapped July 1, 1924, to June 30, 1925	Total area mapped to June 30, 1925
	Sq. miles	Sq. miles			Sq. miles	Sq. miles
Alabama.....	523	20,157	38.7	New Jersey.....		4,410
Arizona.....		55,680	48.7	New Mexico.....		4,410
Arkansas.....		21,494	40.3	New York.....	489	4,410
California.....	1,737	123,651	78.1	North Carolina.....	87	1,100
Colorado.....	936	53,695	51.6	North Dakota.....		1,100
Connecticut.....		4,965	100.0	Ohio.....		4,410
Delaware.....		2,370	100.0	Oklahoma.....		3,300
District of Colum- bia.....		70	100.0	Oregon.....	1,145	2,285
Florida.....		4,716	8.0	Pennsylvania.....	1,198	3,300
Georgia.....		24,835	41.9	Rhode Island.....		1,100
Idaho.....	577	29,299	34.7	South Carolina.....		1,100
Illinois.....	2,048	26,892	47.4	South Dakota.....		1,100
Indiana.....	17	3,644	10.0	Tennessee.....	112	2,285
Iowa.....	50	12,583	22.4	Texas.....	3,721	8,410
Kansas.....		64,159	78.0	Utah.....	624	1,100
Kentucky.....	194	20,723	51.0	Vermont.....	415	6,000
Louisiana.....		8,810	18.2	Virginia.....	456	3,300
Maine.....	203	11,643	35.2	Washington.....	573	3,300
Maryland.....		12,327	100.0	West Virginia.....		2,285
Massachusetts.....		8,296	100.0	Wisconsin.....	477	1,100
Michigan.....		11,153	19.2	Wyoming.....		3,300
Minnesota.....		7,854	8.7			
Mississippi.....		3,881	8.3	Total contin- ental		
Missouri.....	1,178	42,385	61.0	United		
Montana.....		41,590	28.5	States (ex- clusive of Alaska).....	17,322	1,265,385
Nebraska.....		27,117	35.0		481	4,123
Nevada.....		41,141	37.5			
New Hampshire.....	263	4,498	48.1	Hawaii.....		

U. S. GEOLOGICAL SURVEY





GENERAL OFFICE WORK

Computations for vertical and horizontal control were made, and the results were copied and cataloged by the computing section. The section of relief maps completed shaded relief maps of Connecticut, Massachusetts, New York, and Rhode Island; a special map of portions of New York, New Jersey, and Connecticut; and special maps of the Needle Mountains and Santa Maria Lake, Colorado; and of parts of Maine, New Hampshire, New Mexico, Pennsylvania, Tennessee, and Vermont. The map information office was engaged in indexing and cataloging the map data available in the several Federal departments and a number of non-Federal organizations and in furnishing miscellaneous map information to the public.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

The section of inspection and editing of topographic maps continued to supervise the office preparation of all topographic maps and to inspect and edit them before reproduction. It also edited a number of maps submitted by other Survey branches and Government bureaus, including a new sheet of standard map symbols printed by the Geological Survey for the Board of Surveys and Maps.

The number of topographic maps in progress in the topographic branch (exclusive of those being engraved and printed) ranged from 246 in August to 300 in January; the monthly average was 272. An average of 21 employees were engaged in this section for the year, including an average of 3 temporarily assigned for drafting.

James McCormick spent 10 months of the year in work for the United States Geographic Board and in other special investigations and 2 months in revising the "Geographic dictionary of Alaska."

The work of this section is described further under "Publication branch" (p. 85).

SECTION OF PHOTOGRAPHIC MAPPING

The use of aerial photographs in topographic mapping greatly increased during the year, owing to the development of satisfactory methods of compilation. This work was undertaken in cooperation with the Air Service of the United States Army and the Bureau of Aeronautics of the United States Navy. Base maps for original surveys of 25 quadrangles in Texas, 3 in Missouri, 2 in Illinois, and 2 small areas in Indiana and Arizona were prepared. Base maps were also compiled for the resurvey of 42 quadrangles in Texas, 1 quadrangle in New York, and 6 quadrangles and a special area in Illinois. A revision of maps of 3 quadrangles in Texas was completed, a woodland sheet for the Indian Head quadrangle, Va.-Md., was prepared, and work on 5 quadrangles in Illinois, Tennessee, and New York was begun.

SECTION OF CARTOGRAPHY

The compilation of the new wall map of the United States was continued, 50 per cent being completed. Other map projects included the final corrections for sheet K-18 of the international map

and the revision of the maps of Alabama, Virginia, and Florida. Air-route maps for the Air Service of the United States Army were completed in sections, as follows: From New Orleans, La., to Beaumont, Tex.; from Iowa City, Iowa, to Omaha, Nebr.; and from Omaha to North Platte, Nebr. The results of surveys of streams in Colorado and Idaho were assembled and redrafted, and several quadrangle maps were inked. The compilation of the map of California was completed in pencil, and the road map of Illinois was further revised for the State and transmitted for printing. An Albers projection for the wall map of the United States was constructed on metal for use in the engraving of the map. Plate proofs of 23 quadrangle maps were corrected and submitted for the printing of enlarged maps for use in the regional planning of New York City and environs. Graphs were prepared for the Federal Board for Vocational Education, and maps of the Texas-Oklahoma boundary line were prepared for printing.

ATLANTIC DIVISION

FIELD WORK

Alabama.—In cooperation with the State geologist of Alabama the survey of the Gravelly Springs and Tusculum quadrangles was completed and that of the Barton quadrangle was begun, 523 square miles being mapped (scale 1:62,500, contour interval 20 feet). For the control of these areas 73 miles of primary levels were run and 16 permanent bench marks established, and 69 miles of primary traverse were run and 5 permanent marks set.

Indiana.—In cooperation with the Culver Military Academy the survey of a special area in the vicinity of Culver, Ind., was completed for the War Department, 17 square miles being surveyed (scale 1:20,000, contour interval 20 feet).

Kentucky.—In cooperation with the State Geological Survey of Kentucky the survey of the Cub Run, Scottsville, and Waddy quadrangles was completed and that of the Taylorsville quadrangle was begun, 194 square miles being surveyed (scale 1:62,500, contour interval 20 feet). A part of the mapping of the Cave in Rock quadrangle was revised.

Maine.—In cooperation with the Maine State Water Power Commission the survey of the Dead River quadrangle was begun, and that of the Pierce Pond quadrangle was continued, 203 square miles being surveyed (scale 1:62,500, contour interval 20 feet). For control, 140 miles of primary levels were run and 28 permanent bench marks established.

New Hampshire.—In cooperation with the Governor of New Hampshire the survey of the Concord quadrangle was completed, and that of the Boscaawen quadrangle was begun, 263 square miles being mapped (scale 1:62,500, contour interval 20 feet). For control in New Hampshire 430 miles of primary levels were run and 102 permanent bench marks established, and 26 triangulation stations were occupied and 17 triangulation stations permanently marked.

New York.—In cooperation with the New York State engineer the survey of the Deposit, Greenwood, Wellsville, and Woodhull quadrangles and the New York portion of the Starrucca quadrangle was completed, 489 square miles being surveyed (scale 1:62,500, contour interval 20 feet). The resurvey of the Albany, Troy, and Schenectady quadrangles was begun, 78 square miles being mapped (scale 1:62,500, contour interval 20 feet). For the control of these areas 199 miles of primary levels were run and 51 permanent bench marks established.

Ohio.—The resurvey of the Delaware quadrangle was completed, 187 square miles being surveyed (scale 1:62,500, contour interval 10 feet).

Pennsylvania.—In cooperation with the Pennsylvania Department of Forests and Waters, Topographic and Geologic Survey, the survey of the Bradford, Brookville, Center Hall, Lewistown, and Menno quadrangles and the Pennsylvania portion of the Bushkill quadrangle was completed, and that of the Bloss-

burg, Eagles Mere, Hawley, Mifflintown, and Sideling Hill quadrangles was begun, 1,198 square miles being surveyed (scale 1:62,500, contour interval 20 feet). For control, 585 miles of primary levels were run and 150 permanent bench marks established, and 187 miles of primary traverse were run and 89 permanent marks set.

Tennessee.—In cooperation with the Tennessee State Highway Department the survey of the La Follette-Jellico highway project was completed, and that of the Waverly-Camden highway project was begun, 36 square miles being mapped (scale 1:24,000, contour intervals 10 and 20 feet). In addition, the survey of the Tennessee portion of the Byrdstown quadrangle was completed, 76 square miles being surveyed (scale 1:62,500, contour interval 20 feet). For control, 182 miles of primary levels were run and 73 permanent bench marks established, and 80 miles of primary traverse were run and 24 permanent marks set. In cooperation with the Tennessee State geologist 27 miles of primary levels were run and 8 permanent bench marks established, and 77 miles of primary traverse were run and 22 permanent marks set in the Tompkinsville quadrangle.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Randolph quadrangle was completed, and that of the Underhill quadrangle was begun, 195 square miles being surveyed (scale 1:62,500, contour interval 20 feet). The survey of the Island Pond quadrangle was completed for the War Department, 220 square miles being mapped (scale 1:62,500, contour interval 20 feet). For control, 230 miles of primary levels were run and 57 permanent bench marks established.

Virginia.—In cooperation with the State geologist of Virginia the survey of the Draper and Martinsville quadrangles was completed, and that of the Rocky Mount quadrangle was begun, 543 square miles being surveyed (scale 1:62,500, contour interval 20 feet). Of this area 87 square miles is in North Carolina. For the control of the Critz quadrangle 71 miles of primary levels were run and 24 permanent bench marks established, and 27 miles of primary traverse were run and 7 permanent marks set.

West Virginia.—In cooperation with the State geologist of West Virginia the revision of the mapping of 15 quadrangles was completed.

OFFICE WORK

The drafting of 26 sheets was completed and that of 5 sheets begun. Primary-level circuits were adjusted for 49 quadrangles. Geographic positions were computed for 29 quadrangles.

CENTRAL DIVISION

FIELD WORK

Colorado.—In cooperation with the State engineer of Colorado the survey of the Fraser and Montezuma quadrangles was completed, 441 square miles being surveyed (scale 1:62,500, contour interval 50 feet); and that of the Pagosa Springs quadrangle was completed, 330 square miles being surveyed (scale 1:125,000, contour interval 100 feet). In addition, the survey of the Mount Harris quadrangle was completed and that of the Pagoda No. 4, Rabbit Ears Peak No. 2, and Rabbit Ears Peak No. 3 quadrangles was begun, 165 square miles being mapped (scale 1:62,500, contour interval 50 feet). The resurvey of the Ignacio quadrangle was begun, 185 square miles being mapped (scale 1:125,000, contour interval 100 feet). For control, 150 miles of primary levels were run and 29 permanent bench marks established, and 14 triangulation stations were occupied and 22 triangulation stations permanently marked.

Illinois.—In cooperation with the Department of Registration and Education of Illinois the survey of the Beardstown, Duquoin, Griggsville, McHenry, Paxton, Pinckneyville, Pittsfield, Roodhouse, Waverly, and Winchester quadrangles was completed, and that of the Brighton, Chandlerlerville, Galesburg, Gibson City, Manito, Pearl, and Streator quadrangles was begun, 2,048 square miles being surveyed (scale 1:62,500, contour intervals 10 and 20 feet). The resurvey of Camp Grant and vicinity was completed, 57 square miles being surveyed (scale 1:20,000, contour interval 10 feet). The resurvey of the Des Plaines No. 1 and Riverside No. 1 quadrangles, in connection with the resurvey of Chicago and vicinity, was begun, 22 square miles being surveyed

(scale 1:24,000, contour interval 5 feet). A part of the mapping of the Liberty quadrangle was revised. For control, 1,038 miles of primary levels were run and 328 permanent bench marks established, and 1,430 miles of primary traverse were run and 365 permanent marks set.

Iowa.—In cooperation with the Iowa State Geological Survey the survey of the Albia quadrangle was continued, 50 square miles being surveyed (scale 1:62,500, contour interval 20 feet). For control, 8 miles of primary levels were run and 1 permanent bench mark established.

Missouri.—In cooperation with the State geologist of Missouri the survey of the Alton, Bolckow, Bonfils, Dearborn, Edge Hill, Maitland, Meramec Springs, St. Joseph, and Sugar Lake quadrangles was completed, and that of the Exchange, Shell Knob, and Skidmore quadrangles was begun, 1,126 square miles being surveyed (scale 1:62,500, contour interval 20 feet). The survey of the Current River project was completed, 52 square miles being surveyed (scale 1:12,000, contour interval 20 feet). This work was so performed that its results may be incorporated into the regular map of the Exchange quadrangle, of which the area surveyed is a part. For control, 340 miles of primary levels were run and 93 permanent bench marks established, and 413 miles of primary traverse were run and 120 permanent marks set.

Texas.—In cooperation with the Texas State Board of Water Engineers the survey of the Ballfinger 8-d, 4-c; Breckenridge 1-a, 1-b, 1-d; Brady 1-a, 1-b, 2-a, 2-b; Brownwood 3-b, 3-d, 4-c; Burnet 2-c, 3-b, 3-d; Coleman 1-a; Cotulla 2-a, 2-b; Dallas 2-b; Eden 1-a; Fort Worth 1-a; Georgetown 4-a, 4-b, 4-c, 4-d; Graham 4-c, 4-d; Granbury 4-a; Hunter 3; Iola 2; McKinney 3-c; Marquez 1, 2; New Braunfels 1, 4; Oakville 2 and 4; Orla 2-b; Palo Pinto 2-c, 2-d, 4-b; Pearsall 1-b, 1-c; San Marcos 1-d, 3-c, 3-d, 4-a, 4-c; San Saba 1-b, 1-c, 1-d, 2-a, 2-b, 4-a; Smithsons Valley 1, 2; Sunset 4-d; Tordia 1; and Weatherford 1—a quadrangles was completed, and that of the Mathis 2, Mathis 3, and San Roque Lake 1-a quadrangles was begun, 3,481 square miles being surveyed (scale 1:62,500, contour intervals 10 and 20 feet). Surveys of parts of reservoir sites falling outside of completed regular quadrangles amount to an additional 178 square miles. A special survey covering 62 square miles in Tarrant County was completed, for which the county bore the entire expense. For control, 2,555 miles of primary levels were run and 609 permanent bench marks established, and 1,812 miles of primary traverse were run and 426 permanent marks set. Eight triangulation stations were occupied and 8 triangulation stations marked.

Wisconsin.—In cooperation with the State geologist of Wisconsin the survey of the Black River Falls, Blair, Gays Mills, Stoddard, and Wauzeka quadrangles was completed, the survey of the Osseo quadrangle was continued, and that of the Boaz quadrangle was begun, 477 square miles being surveyed (scale 1:62,500, contour interval 20 feet). A part of the mapping of the Waukon quadrangle was revised. For control, 164 miles of primary levels were run and 23 permanent bench marks established, and 355 miles of primary traverse were run and 101 permanent marks set.

OFFICE WORK

The drafting of 88 sheets was completed and that of 81 sheets was begun. Primary-level circuits were adjusted for 95 quadrangles. Geographic positions were computed for 143 quadrangles.

PACIFIC DIVISION

FIELD WORK

California.—In cooperation with the California Department of Public Works the survey of the Exeter, Klink, Lemon Cove, Lethent, No. 35, No. 37, Paige, Remnoy, Tulare, and Visalia quadrangles was completed, 535 square miles being mapped (scale 1:31,680, contour interval 5 feet). In cooperation with Los Angeles County the survey of the Altadena, Burbank, Chatsworth, Covina, Dry Canyon, Duarte, Glendale, Glendora, La Crescenta, La Habra, La Verne, Los Angeles, Mount Lowe, Pacoima, Point Vicente, Puente, Sierra Madre, Sunland, Sylmar, Topanga Canyon, and Zelzah quadrangles was completed, and that of the Claremont, La Brea, Reseda, and San Pedro Hills quadrangles was begun, 638 square miles being mapped (scale 1:24,000, contour interval

feet). In cooperation with the East Bay Municipal Utility District the survey of the Covelo and Laytonville No. 4 quadrangles was completed, and that of the Ukiah No. 1 was begun, 262 square miles being mapped (scale 1:62,500, contour interval 50 feet). The survey of the Salton Sea project was completed for the land-classification branch, 284 square miles being mapped (scale 1:62,500, contour interval 10 feet). A plan and profile survey of Eel River, also for the land-classification branch, was begun, 18 square miles being mapped (scale 1:31,680, contour intervals 5 and 25 feet), and 10 linear miles of river being traversed. For control, 624 miles of primary levels were run and 159 permanent bench marks established, and 47 triangulation stations were occupied and 29 triangulation stations permanently marked. At the request of the National Park Service 31 miles of primary levels were run and 27 permanent bench marks established for the control of the Lassen Peak quadrangle.

Hawaii.—In cooperation with the Territory of Hawaii the survey of the Haleakala NE $\frac{1}{4}$, NW $\frac{1}{4}$, Hamo, Hana, Kailua NE $\frac{1}{4}$, NW $\frac{1}{4}$, SE $\frac{1}{4}$, SW $\frac{1}{4}$, Kauhako NE $\frac{1}{4}$, NW $\frac{1}{4}$, SE $\frac{1}{4}$, SW $\frac{1}{4}$, and Koolau SE $\frac{1}{4}$, SW $\frac{1}{4}$ quadrangles was completed, and that of the Hoopuloa NE $\frac{1}{4}$ quadrangle was begun, 481 square miles being surveyed (scale 1:31,680, contour interval 50 feet). For the control of these areas 42 miles of primary levels were run and 12 permanent bench marks established.

Idaho.—At the request of the Forest Service the survey of the Casto quadrangle was continued, 275 square miles being surveyed (scale 1:125,000, contour interval 100 feet). The survey of the Ammon and Hell Creek quadrangles was completed for the geologic branch, 267 square miles being surveyed (scale 1:62,500, contour interval 50 feet). Plan and profile surveys of Clearwater River and Salmon River were completed, 487 miles of river being traversed and mapped. A plan and profile survey of Payette River was begun, 35 square miles being mapped (scale 1:31,680, contour interval 20 feet), and 130 linear miles of river being traversed. This work was done for the land-classification branch. For control, 146 miles of primary levels were run and 45 permanent bench marks established.

Oregon.—In cooperation with the State engineer of Oregon the survey of the McMinville quadrangle was completed, 210 square miles being mapped (scale 1:62,500, contour interval 25 feet). The survey of the Mount Hood quadrangle was completed for the Forest Service, and that of the Mitchell quadrangle was completed for the geologic branch, 920 square miles being mapped (scale 1:125,000, contour interval 100 feet). A plan and profile survey of Umpqua River and its tributaries was completed and that of the South Fork of Coquille River and Siletz River was begun for the land-classification branch, 118 linear miles of river being traversed. In connection with these surveys maps of reservoir sites covering 15 square miles (11 square miles, scale 1:12,000; 4 square miles, 1:31,680; contour interval 10 feet) were made, and several dam sites were surveyed. For control, 20 miles of primary levels were run and 5 permanent bench marks established, and 14 triangulation stations were occupied and 9 triangulation stations marked.

Utah.—In cooperation with Box Elder, Salt Lake, Tooele, Utah, and Weber counties, Utah, and the United States Bureau of Reclamation the survey of these counties was continued, 283 square miles being mapped (scales 1:62,500 and 1:24,000, contour interval 5 feet). The survey of the Fort Douglas quadrangle was continued for the Forest Service, 270 square miles being mapped (scale 1:125,000, contour interval 100 feet). At the request of the geologic branch, 71 square miles of the Gold Hill quadrangle was mapped (scale 1:24,000, contour interval 25 feet). A plan and profile survey of Duchesne River and its tributaries was completed and that of San Rafael River was begun for the land-classification branch, 112 linear miles of river being traversed. For control, 116 miles of primary levels were run and 33 permanent bench marks established. In cooperation with the Department of Military Science and the Department of Geology of the University of Utah 4 triangulation stations were occupied and 3 triangulation stations permanently marked for the control of a special area in the vicinity of Fort Douglas.

Washington.—In cooperation with the Washington State Department of Conservation and Development the survey of the Chewelah quadrangle was continued, 390 square miles being mapped (scale 1:125,000, contour interval

100 feet). The survey of the Mount Rainier quadrangle was completed for the Forest Service, 469 square miles being mapped (scale 1:125,000, contour interval 100 feet). A plan and profile survey of Stillaguamish River was begun for the land-classification branch, 14 square miles being surveyed (scale 1:31,680, contour intervals 10 and 25 feet). In connection with this work several dam sites were surveyed.

OFFICE WORK

The drafting of 50 sheets was completed and that of 21 sheets was begun. Primary-level circuits were adjusted for 105 quadrangles. Geographic positions were computed for 47 quadrangles.

WATER-RESOURCES BRANCH

ORGANIZATION

The work of the water-resources branch was conducted under the supervision of N. C. Grover, chief hydraulic engineer, and is organized in five divisions:

Division of surface water, John C. Hoyt, hydraulic engineer, in charge.

Division of ground water, O. E. Meinzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

Division of land-classification investigations, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL

During the year the technical force was reduced 17 and was increased 10, a net decrease of 7. At the end of the year the force consisted of 1 chief hydraulic engineer, 1 senior hydraulic engineer, 34 hydraulic engineers, 3 associate hydraulic engineers, 10 engineers, 1 associate engineer, 26 assistant engineers, 32 junior engineers, 3 geologists, 1 associate geologist, 3 assistant geologists, 2 chemists, and 1 assistant chemist, a total of 118. Of this number 3 hydraulic engineers, 2 engineers, 2 assistant engineers, 3 junior engineers, and 1 assistant geologist were employed occasionally.

In the clerical force there were 8 separations and 2 accessions, and at the end of the year the force numbered 27. Of this number 3 have been employed only at times.

ALLOTMENTS

The appropriation for gaging streams was \$170,000. In addition \$16,722.74 of the appropriation for the adjustment of field salaries and \$75,233.02 of the appropriation for the classification of lands was expended for field work by the water-resources branch. Of the total appropriations 60 per cent was allotted to work in public-land States. The cooperative funds made available by State allotments have been increased in some States and decreased in others, and the changes have necessitated corresponding adjustments of this work. The amount of these funds available for the year was \$313,815.07. With repayments for services rendered other branches of the Government—\$34,004.52—the total expenditures for work under the administration of this branch were \$603,954.15.

Allotments of funds for gaging streams, 1924-25

Administration, general.....	\$18,149.10
Branch administration.....	12,925.00
Inspection.....	500.00
Computations.....	17,160.00
	<hr/>
	48,734.10

Surface water:	
Maine.....	600.00
New Hampshire.....	1,500.00
Vermont.....	500.00
Massachusetts.....	2,500.00
Connecticut.....	400.00
New Jersey.....	2,900.00
New York.....	4,500.00
Middle Atlantic States.....	3,600.00
North Carolina.....	3,600.00
Tennessee.....	2,900.00
Ohio.....	2,900.00
Texas.....	4,300.00
Wisconsin.....	3,250.00
Minnesota.....	250.00
Iowa.....	2,000.00
Illinois.....	1,500.00
Missouri.....	3,600.00

Surface water—Continued.	
Kansas.....	\$3,300.00
Colorado, Wyoming, and New Mexico.....	5,500.00
Montana.....	4,300.00
North Dakota.....	300.00
Utah.....	4,300.00
Nevada.....	2,500.00
Idaho (Boise).....	3,200.00
Idaho (Idaho Falls).....	1,100.00
Oregon.....	4,300.00
Washington.....	4,300.00
California.....	4,500.00
Arizona.....	3,300.00
Hawaii.....	4,500.00
	<hr/>
	86,200.00
	<hr/>
Ground water.....	9,700.00
Quality of water.....	14,400.00
Power resources.....	7,700.00
General supplies.....	500.00
Books for library.....	150.00
Contingent.....	2,615.84
	<hr/>
Grand total.....	170,000.00

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Alabama.....	\$60.00
Arizona:	
Stream gaging.....	\$10,000.00
Colorado River.....	7,000.00
	<hr/>
	17,000.00
California:	
State.....	21,535.26
County and city.....	10,299.31
	<hr/>
	31,834.57
Colorado:	
State.....	1,500.00
Municipal.....	370.00
	<hr/>
	1,870.00
Hawaii.....	24,334.25
Idaho State Department of Reclamation:	
Outside of upper Snake River basin.....	13,970.66
Upper Snake River basin.....	2,824.87
	<hr/>
	16,795.53
Illinois:	
State.....	4,239.29
Municipal.....	60.00
	<hr/>
	4,299.29

Iowa:		
State Highway Commission.....	\$2,385.80	
State Geological Survey.....	499.97	
		\$2,885.77
Kansas:		
State.....	4,895.69	
Municipal.....	60.00	
		4,955.69
Maine.....		5,278.28
Maryland.....		84.88
Massachusetts.....		3,196.95
Minnesota.....		554.70
Missouri:		
State.....	9,291.54	
Municipal.....	180.00	
		9,471.54
Montana.....		6,003.47
Nevada.....		2,596.10
New Hampshire.....		1,160.99
New Jersey:		
Stream gaging.....	11,089.40	
Ground water.....	6,559.82	
		17,649.22
New York.....		15,492.00
North Carolina.....		9,693.83
North Dakota.....		500.00
Ohio.....		25,133.57
Oregon:		
State.....	6,452.01	
Municipal.....	1,482.17	
		7,934.18
Tennessee.....		3,881.48
Texas.....		72,238.34
Utah.....		5,815.29
Virginia.....		4,138.02
Washington:		
State.....	5,761.62	
Municipal.....	1,729.81	
		7,491.43
West Virginia:		
State.....	496.83	
Municipal.....	53.08	
		549.91
Wisconsin.....		6,161.02
Wyoming.....		4,755.27
		313,815.07

The work done under cooperative agreements with the States been restricted to studies of stream flow, except in Arizona, Jersey, and North Dakota, where ground-water investigations have been made. (See pp. 70-71.)

Bureau of Reclamation.—The measurement of streams that furnish water to reclamation projects under construction was continued in cooperation with the Bureau of Reclamation. The work was done by Survey engineers, who were employed the measurements were made, and the cost was met by the of Reclamation through transfer of funds. Geologic invest of reservoir sites or ground-water supplies were made for the of Reclamation in California, Oregon, and Washington. (70-71.)

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued in the Fort Hall, Yakima, Colville, Klamath, Wind River Diminished, Western Shoshone, Walker River, and Uinta Indian reservations and for a short time in the Crow Indian Reservation. Some stream gaging was also done in the Blackfeet and Fort Peck Indian reservations.

National Park Service.—Streams in the Yosemite and Yellowstone national parks were measured during the year at stations maintained in cooperation with the National Park Service.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service.

Weather Bureau.—Stream gaging has been done on Colorado River in Arizona in cooperation with the Weather Bureau.

Federal Power Commission.—Projects of the Federal Power Commission in Arizona, Colorado, and Oregon were examined, and the examination of one in Utah is in progress. The operation of 10 licensees of the commission in California, 1 in Arizona, 3 in Idaho, 1 in Oregon, 1 in Idaho-Oregon, 1 in Nevada, and 5 in Washington were supervised by the Geological Survey, as well as the operations of 2 permittees of the commission in Arizona, 3 in Idaho, 2 in Oregon, 1 in Utah-Wyoming, 1 in New Mexico, and 1 in Montana. All stream gaging by permittees of the commission is done in cooperation with the Geological Survey. Such cooperative stream gaging is in progress in Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Montana, New Mexico, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Utah, Washington, West Virginia, Wisconsin, and Wyoming.

Office of the Chief of Engineers.—Stream gaging has been done in the basins of Tennessee and Cumberland rivers in cooperation with the Office of the Chief of Engineers.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 18 reports and 8 separate chapters. Titles and brief summaries of these publications are given elsewhere in this report. At the end of the year 21 other reports were in press and 9 manuscripts were awaiting editorial work.

DIVISION OF SURFACE WATER

ORGANIZATION

The work of the division of surface water consists primarily of the measurement of the flow of rivers, but it includes also special investigations of conditions affecting stream flow and the utilization of the streams. In carrying on the work the United States is divided into 23 districts, including Hawaii. The district offices and engineers in charge are as follows:

New England: C. H. Pierce, Customhouse, Boston, Mass.

New York: A. W. Harrington, Journal Building, Albany, N. Y.

New Jersey: O. W. Hartwell, Statehouse, Trenton, N. J.
 Middle Atlantic: A. H. Horton, Washington, D. C.; suboffice, care of University of Virginia, Charlottesville, Va.
 South Atlantic: E. D. Burchard, Jackson Building, Asheville, N. C.
 Tennessee: W. B. King, Municipal Building, Chattanooga, Tenn.
 Ohio: Lasley Lee, Brown Hall, Ohio State University, Columbus, Ohio.
 Wisconsin-Minnesota: S. B. Soule, Capitol Building, Madison, Wis.
 Illinois: H. E. Grosbach, Transportation Building, Chicago, Ill.
 Iowa: J. B. Spiegel, State Highway Commission Building, Ames, Iowa.
 Kansas: H. B. Kinnison, Federal Building, Topeka, Kans.
 Missouri: H. C. Beckman, Rolla, Mo.
 Montana-North Dakota: W. A. Lamb, Federal Building, Helena, Mont.
 Colorado-Wyoming: Robert Follansbee, Post Office Building, Denver, Colo.
 Utah-Nevada: A. B. Purton, Federal Building, Salt Lake City, Utah.
 Idaho: C. G. Paulsen, Federal Building, Boise, Idaho.
 Snake River basin: G. C. Baldwin, Federal Building, Idaho Falls, Idaho.
 Washington: G. L. Parker, Federal Building, Tacoma, Wash.
 Oregon: F. F. Henshaw, Post Office Building, Portland, Oreg.
 California: H. D. McGlashan, Customhouse, San Francisco, Calif.; suboffice, Federal Building, Los Angeles, Calif.
 Arizona: W. E. Dickinson, care of University of Arizona, Tucson, Ariz.
 Hawaii: Max Carson, Capitol Building, Honolulu, Hawaii.
 Texas: C. E. Ellsworth, Capitol Building, Austin, Tex.

CHARACTER AND METHOD OF WORK

Field investigations necessary to the work are made from the district offices, where the results are examined and corrected, if correction is necessary, to insure their accuracy and completeness. At selected gaging stations the volume of water carried by the streams is measured and records of stage and other data are collected from which the daily flow of the streams is computed. The data thus collected are transmitted from the district offices to Washington, where they are reviewed in the computing section and prepared for publication. By this review the records obtained in different parts of the country are brought to a uniform standard, and standardization is further effected through annual conferences of the engineers.

At the end of the year 1,715 gaging stations were being maintained, including 73 in Hawaii; 286 stations were discontinued and 328 new stations established during the year. Records for about 142 additional stations were received, ready for publication, from Government bureaus and private persons, and a number of Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

Gaging stations and cooperating parties for the year ended June 30, 1925

State or Territory	Geological Survey alone	Bureau of Reclamation	Forest Service	Indian Office	Army engineers	Weather Bureau	Other Federal bureaus	State cooperation	Municipal cooperation	Private persons	Counted more than once	Maintained at end of year	Established during year	Discontinued during year	Regular gagings during year	Miscellaneous gagings during year
Alabama					2	1			1	11	2	13	4		45	4
Arizona		2		1		3	3	36	4	3	16	36	7		893	44
Arkansas										2		2	1	1	18	
California		20	1				5	207	51	93	168	269	15	24	3,224	708
Colorado		2	2					29	3	6	10	32	2	7	80	3
Connecticut										2		2		1	5	
Florida										3		1			5	
Georgia										3		3	1		27	2
Idaho		8	5	11		2		112	3	206	99	248	124	120	2,089	274
Illinois					2	2		29	1	1	6	29	1	1	62	3
Iowa						6		23		6	8	27			83	3
Kansas						4		30	1	9	14	30		2	216	1
Kentucky					10	1				13	11	13	8	1	78	
Louisiana										3		3			6	1
Maine								17		5	5	17	1		115	
Maryland	2							2	2	3	3	6	4	2	41	5
Massachusetts								18		1	1	18			108	1
Michigan										2		2	1		15	
Minnesota					2			6		6		14	3		36	4
Missouri						1		55		13	14	55	2	2	349	9
Montana	6	22	2				15	35		5	14	71	3	35	307	5
Nevada				3				22	4	7	14	22	3	6	102	14
New Hampshire								15		11	11	15	1	1	102	1
New Jersey						1		36	5	8	14	36		1	240	105
New Mexico	1											1			3	5
New York					1			70	2	35	38	70	17	5	466	9
North Carolina					1	1		45	3	10	13	47	32	16	193	16
North Dakota								9				9	3	2	19	
Ohio						5		45		7	2	67	5	4	479	19
Oklahoma					4				8			6	1		19	
Oregon		2	1	5		8		82	25	39	75	87	6	7	515	68
South Carolina										1		1				
Tennessee					38	11		43		8	57	43	2	2	272	19
Texas						11	5	148	13	18	47	148	28	3	1,467	462
Utah		1		5			1	51	2	20	29	51	2		117	7
Vermont										7		7			15	5
Virginia					7	1		34	1	4	13	34	34	14	88	
Washington	2		4	8			2	47	25	24	47	65	8	6	462	44
West Virginia					5			6	1	10	3	19		1	19	7
Wisconsin					3			43		10	13	43	3		178	27
Wyoming	1	6		5		1	6	22		4	5	40	4	19	154	
Hawaii								73	3	15	18	73	2	2	311	182
	11	44	34	39	75	59	37	1,390	158	638	770	1,715	328	286	12,943	2,057

PUBLICATIONS

For convenience and uniformity in publications, the United States has been divided into 12 primary drainage basins, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions; the records for the twelfth division are published in three papers. In addition to the progress reports, special reports on hydraulic subjects have been completed for publication during the year.

DIVISION OF GROUND WATER

GENERAL FEATURES

The division of ground water investigates the waters that lie below the surface—their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domes-

tic, industrial, irrigation, and public supplies and at watering places for livestock and desert travelers. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to quality of water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects.

A hydraulic laboratory, in charge of Mrs. N. D. Stearns, is maintained for determining the mechanical composition, porosity, moisture equivalent, and permeability of water-bearing materials. A paper describing the methods used and giving the results of about 100 tests of water-bearing materials was practically completed by Mrs. Stearns.

During the year O. E. Meinzer completed his paper entitled "Large springs in the United States" and wrote a paper on plants as indicators of ground water. He also made progress on his paper on the origin, discharge, and quantity of ground water in the United States. Mrs. Stearns began a study of the thermal springs of the United States and partly prepared a paper on this subject. All these reports are to be published as water-supply papers.

In January, 1925, Mr. Meinzer delivered two lectures on ground water at the annual meeting of the North Dakota Well Drillers Association in Fargo, N. Dak.

Mr. Bryan was furloughed for several weeks to make a study, for the National Geographic Society, of the geology in the vicinity of the ruins of Pueblo Bonito, in Chaco Canyon, N. Mex. Mr. Meinzer was furloughed in February, 1925, to make a geologic study of reservoir sites in Cuba.

Cooperation with the committee on physiography was continued through Mr. Meinzer, who serves on that committee. Several manuscripts were examined for the geologic branch with respect to their treatment of ground water.

WORK OF THE YEAR BY STATES

Arizona.—Progress was made on a report on the geology and water resources of San Pedro Valley, Ariz., by Kirk Bryan, of the Geological Survey, and G. E. P. Smith, of the Arizona Agricultural Experiment Station.

Arkansas.—Studies of the temperature and mineral composition of the water of Hot Springs National Park, Ark., were continued by Mr. Bryan in cooperation with W. D. Collins.

California.—Water levels were measured in selected wells in southern California, as in previous years, under the direction of F. C. Ebert. An investigation relating to an additional water supply from wells for the Mare Island Navy Yard was made by B. C. Renick, and a report thereon was sent to the commandant of the navy yard. A dam site for a salt-water barrier in the lower reaches of Sacramento and San Joaquin rivers was examined by Mr. Bryan, and a report on this subject was submitted to the Bureau of Reclamation.

Delaware.—A brief study of the new well and municipal water supply at Laurel, Del., was made by Mr. Meinzer and D. G. Thompson.

Hawaii.—Field work was completed by H. T. Stearns in the Kau district, Island of Hawaii, and progress was made on a report on the geology and

ground-water conditions in that district by Messrs. Stearns and Clark. Several short articles were also prepared by Mr. Stearns on the volcanic and ground-water conditions in the Hawaiian Islands and in other volcanic areas which he visited in his trip around the world.

Idaho.—Observations were continued in the Mud Lake basin, Idaho, through cooperation with C. G. Paulsen, district engineer. Progress was made on the final report on the Mud Lake basin by Mr. Stearns. A report by A. M. Piper on the geology and water resources of the Bruneau River basin, Owyhee County, was published as Pamphlet 11 of the Idaho Bureau of Mines and Geology.

Louisiana.—An examination was made by B. C. Renick, in June, 1925, in regard to a water supply from wells for the town of Colfax, La.

Maryland.—A brief examination was made by Messrs. Meinzer and Thompson concerning a new ground-water supply for the city of Salisbury, Md.

Michigan.—A preliminary examination was made by Mr. Meinzer of a proposed ground-water supply for Saginaw, Mich., and a brief manuscript report to the city engineer was made by him in conjunction with D. H. Maury and W. C. Hoad, consulting engineers.

Montana.—A report on ground water in Big Horn County, Mont., was practically completed by G. M. Hall, who also made some progress on a similar report for Fergus County. A report on ground water in central and southern Rosebud County was prepared by Mr. Renick. A brief examination was made for the United States Forest Service by Mr. Bryan relating to additional ground-water supplies for stock in the Helena National Forest.

New Jersey.—The investigation of the quantities of ground water available for public and industrial supplies in New Jersey was continued during the year in cooperation with the State Department of Conservation and Development. The work has been in charge of Mr. Thompson, who was assisted by E. W. Downs. Special attention was given to the conditions in the Atlantic City and Asbury Park regions. A report on the work of the two years ending June 30, 1925, was practically completed by Mr. Thompson.

New Mexico.—A survey of the ground-water conditions in a part of Sandoval County, N. Mex., was completed by Mr. Renick, and a mimeographed bulletin on the area was made public. A water-supply paper on this area is being prepared by Mr. Renick. A survey of ground-water conditions on State lands in Socorro and Torrance counties was started by Mr. Bryan in June, 1925.

North Dakota.—Progress was made by Howard E. Simpson, water geologist of the State Geological Survey, on his report on the ground-water resources of North Dakota.

Oregon.—Field work was completed by Messrs. Bryan and Renick on the geology of the dam site and tunnel lines of the Owyhee project of the United States Bureau of Reclamation, Oreg., and a report thereon was nearly completed.

South Carolina.—Progress was made on a report on the ground water in the Coastal Plain of South Carolina, by C. W. Cooke, of the geologic branch.

Texas.—A report on the Tertiary and Quaternary geology of the lower Rio Grande region, including a ground-water study, has been nearly completed by A. C. Trowbridge, of the geologic branch.

Utah.—An intensive study of the intake and discharge of ground water in the Escalante Desert, Utah, was begun by W. N. White.

Virginia.—A study of the water in Ordovician limestone and shale near Woodstock, Va., in the Shenandoah Valley, was made by Mr. Hall, who prepared a report thereon for publication. A study was also made by Mr. Hall in regard to an improved ground-water supply for the oyster industry on Chincoteague Island, and a manuscript report on this subject was made available to the people of that island.

Washington.—Geologic examinations were made by Mr. Bryan on the Cle Elum Lake and Kittitas projects of the Bureau of Reclamation.

Wyoming.—The ground-water conditions at Gillette, Wyo., were examined by Mr. Bryan, and a manuscript report on a water supply for that town was submitted to the mayor. Eight samples of water-bearing material from the vicinity of Jackson Lake were tested in the hydrologic laboratory in connection with a study of seepage gains and losses that was made by T. R. Newell.

DIVISION OF QUALITY OF WATER

During the year the division of quality of water analyzed 364 samples of water and continued studies of methods of analysis. Analytical work was completed for a report on Pecos River, Tex., and was practically completed for studies of quality of the ground and surface waters in Florida and Rhode Island and surface waters in New Jersey. Analyses were made for ground-water reports on the Cuba area, N. Mex. (20), Camas County, Idaho (7), and Woodstock, Va. (6). Careful analyses were made of four samples from Hot Springs, Ark., in connection with studies of the temperature of the springs. Analyses were made of samples from four places where pipes have been buried in connection with a comprehensive study of soil corrosion that is being conducted by several cooperating organizations whose headquarters are at the Bureau of Standards. Water-Supply Papers 560-B and 560-C were published. (See p. 13.) The report on production of mineral waters in 1923 was prepared for the division of mineral resources. A report on relations between quality of water and industrial development in the United States was transmitted for publication as a water-supply paper. A report on the chemical character of water in Florida was practically completed.

DIVISION OF POWER RESOURCES

The work of the division of power resources during the year comprised the preparation of monthly reports of the production of electricity and consumption of fuel by public-utility power plants, and of a report on the developed water power of the United States.

The monthly reports are based on reports submitted by public-utility companies. About 4,000 power plants, each having a monthly output of 10,000 kilowatt-hours or more, are requested to submit reports of their production of electricity and consumption of fuel.

The total capacity of the generators in these plants in January, 1925, was about 19,400,000 kilowatts. Reports received represent about 95 per cent of the total generating capacity of these plants. Each report is published about 30 days after the end of the last month included in it. The following tables show the power and fuel statistics for the calendar years 1919 to 1924:

Electricity produced at public-utility power plants in the United States, 1919-1924

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)
1919	38,921,000,000		14,606,000,000	37.5		24,315,000,000	62.5	
1920	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921	40,976,000,000	-5.9	14,971,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922	47,659,000,000	+16.3	17,206,000,000	36.1	+14.9	30,453,000,000	63.9	+17.1
1923	55,674,000,000	+16.8	19,348,000,000	34.8	+12.4	36,327,000,000	65.2	+18.3
1924	59,014,000,000	+6.0	19,969,000,000	33.8	+3.2	39,044,000,000	66.2	+7.5

Fuel consumed in the production of power at public-utility plants in the United States, 1919-1924

Year	Coal		Fuel oil		Gas	
	Short tons	Change from previous year (per cent)	Barrels	Change from previous year (per cent)	M cubic feet	Change from previous year (per cent)
1919.....	35, 100, 000	-----	11, 050, 000	-----	21, 406, 000	-----
1920.....	37, 124, 000	+5.8	13, 123, 000	+18.8	24, 702, 000	+15.4
1921.....	31, 585, 000	-14.9	12, 045, 000	-8.2	23, 722, 000	-4.0
1922.....	34, 179, 000	+8.3	13, 197, 000	+9.6	27, 172, 000	+14.5
1923.....	38, 954, 000	+14.0	14, 679, 000	+11.2	31, 433, 000	+15.7
1924.....	37, 556, 000	-3.6	16, 630, 000	+13.3	48, 443, 000	+54.1

Reports on the stock of coal held by electric public-utility power plants were made for inclusion in a report on commercial stocks of coal undertaken by the Bureau of the Census, Department of Commerce, and the Geological Survey on September 1, 1924, and by the Geological Survey alone on June 1, 1925.

DIVISION OF LAND-CLASSIFICATION INVESTIGATIONS

The division of land-classification investigations performed certain technical work required for the classification of public lands with respect to their water resources. The work is done mainly by the use of funds allotted by the land-classification branch, by men from both branches who are sent to the field in summer and spend the winter in the office in preparing reports. The work comprises the examination of public lands for designation under the enlarged and stock-raising homestead laws and the examination of streams and neighboring lands for the classification of public lands with respect to their value for water power or irrigation.

ENLARGED AND STOCK-RAISING HOMESTEADS

The work of examining individual tracts of land for classification under the enlarged and stock-raising homestead laws and of making general reconnaissance examinations was continued during the year, the general examinations being made more especially in the northern Great Plains region and also in the States of Colorado, Idaho, Utah, and Washington. During the summer of 1924 examination was made of all lands included in applications pending at the beginning of the year in Arizona, Colorado, California, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, and Washington, and of most of the lands included in such applications in Wyoming.

An economic study of irrigation in the Casa Grande Valley, Ariz., was made for use in the designation of lands for classification under the homestead laws.

A brief examination of the grazing capacity of lands in Nevada was made for the purpose of supplementing information at hand for the classification of lands under the ground-water reclamation act.

During the field season of 1924 work was begun early in June and by the end of the month had been completed in North Dakota and was in progress in California, Colorado, Montana, Oregon, South Dakota, Utah, and Wyoming.

POWER AND IRRIGATION

Arizona.—To supplement the survey of Colorado River made in the autumn of 1923, an examination and survey was made of promising dam sites in that stretch of the river beginning about 10 miles above Pierces Ferry and ending with the El Dorado dam site, in the lower end of Black Canyon, Ariz., a distance of about 100 miles. Work was completed on the manuscript of a report begun

the previous year on the potential water power and storage capacities of the dam sites on Colorado River below the mouth of the Green. This report will be published as Water-Supply Paper 558, "Water power and flood control of Colorado River below Green River, Utah." At the request of the Federal Power Commission an examination of a project to develop power on Has-sayampa River was made, and a report giving its results was prepared.

Colorado.—Reconnaissance surveys of the power value of streams tributary to the Colorado, including Blue, Dolores, Eagle, Roaring Fork, San Miguel, and Taylor rivers, begun in June, 1924, were completed in September. Manuscript reports containing results of these surveys have been prepared and have been opened or will be opened for public inspection in the Survey offices in Washington, D. C., and Denver, Colo. Work has been continued on a report on the utilization of Colorado River in Colorado and Utah to the mouth of Green River. An investigation of the water-power resources of the upper San Juan River is now in progress. At the request of the Federal Power Commission an examination and a report were made on a project to develop power on Grape Creek. An examination and report were also made for the commission regarding the trespass of a hydroelectric plant upon lands in T. 3 S., R. 7 W. sixth principal meridian.

Idaho.—The selection by a hydraulic engineer of dam and reservoir sites along Clearwater River, Idaho, and its forks for special survey by a topographic party and an investigation of the power value of the stream and adjacent lands was completed in October. A report on the power resources of the Clearwater River basin is now in progress. A reconnaissance examination was made in the Payette River basin for the purpose of planning river and reservoir surveys to be started in the summer of 1924 by a topographic party. A summary report on the power resources of Snake River between Huntington, Oreg., and Lewiston, Idaho, was published as Water-Supply Paper 520-C.

Montana.—A report on water power and irrigation in the Madison River basin, Mont., based on an investigation made in the summer of 1923, was published as Water-Supply Paper 560-A.

Oregon.—Power investigations begun in the previous year of Umpqua River, Oreg., and its important tributaries in connection with river and dam-site surveys have been completed, and a report on the power resources, including the classification of lands, is in progress. Similar investigations were made on the Middle and South forks of Coquille River. The report of this work is also in progress. An office study of the water supply of streams in east and south-central Oregon has been carried on during the year. At the request of the Federal Power Commission an examination and a report were made on project to develop power on Crooked River and on springs in the canyon of Crooked River.

Utah.—An examination of power sites together with the supervision of river and dam-site surveys in the Uinta Basin, Utah, begun in June, 1924, was completed early in the year, and reports for office use on the power value of lands in the basin are in progress. Reports have been made for office use on the power value of certain lands withdrawn as administration sites; also on the irrigability of certain lands relinquished from or included in canceled Carey Act segregation lists. Work has been continued on a report, to be published as a water-supply paper, on the utilization of Green River in Wyoming, Colorado, and Utah. A report on the water powers of the Great Salt Lake basin was published in October as Water-Supply Paper 517. An examination of the power value of the canyon section of San Rafael River and the supervision of plan and profile surveys of that part of the river are now in progress.

Washington.—Work has been started on river surveys and power investigations of streams draining the Olympie Range, Wash. At the request of the Federal Power Commission an examination and a report were made on the power value of certain lands along Sultan River in T. 29 N., R. 8 E.

LAND-CLASSIFICATION BRANCH

ORGANIZATION AND PERSONNEL

At the end of the fiscal year the organization and technical personnel of the land-classification branch were as follows:

Chief, Herman Stabler.

Assistant chief, John D. Northrop.

Chief clerk, Elsie Patterson.

Division of mineral classification: J. D. Northrop, geologist, chief; C. D. Avery and W. W. Boyer, geologists; G. W. Holland, attorney.

Division of hydrographic classification: W. G. Hoyt, hydraulic engineer, chief. Power section: B. E. Jones, hydraulic engineer, chief; J. G. Mathers and N. J. Tubbs, hydraulic engineers; R. O. Helland, classifier. Irrigation section: J. F. Deeds, hydraulic engineer, chief; C. E. Nordeen, hydraulic engineer.

Division of homestead classification: A. E. Aldous, classifier, chief; L. R. Brooks. Depue Falck, E. R. Greenslet, W. L. Hopper, G. M. Kerr, R. E. Morgan, J. Q. Peterson, and O. D. Stanton, classifiers.

In addition, two hydraulic engineers, R. W. Davenport and D. J. Guy, were detailed from the branch for duty with the Federal Power Commission.

During the fiscal year there were 9 additions to the force and 7 separations. At its end the staff numbered 48, including the clerical force and employees detailed to the Federal Power Commission.

SCOPE AND CHARACTER OF THE WORK

During the year the land-classification branch performed the duties of the Geological Survey relating to "the classification of public lands" with which the Director of the Survey is charged by law. The field of its work is coextensive with the public domain of the United States, including Alaska.

The results of the work of the land-classification branch are utilized mainly in the preparation of orders for the withdrawal from entry, restoration to entry, classification, and designation of the public lands, of informative and advisory reports, and of recommendations for appropriate action concerning public lands, made chiefly to the General Land Office, the Secretary of the Interior, the Office of Indian Affairs, and the Federal Power Commission.

FUNDS

The current appropriation of \$280,000 for land classification prior to June 30, 1925, is the same as the appropriation for the preceding year but still \$20,000 below the appropriation available during the year ending June 30, 1922.

CORRESPONDENCE

During the year 14,993 letters and petitions were received by the land-classification branch. In addition 7,500 copies of miscellaneous correspondence were sent to the branch for its information and filing. The miscellaneous correspondence was made up largely of letters from the General Land Office to its local officers and of reports on the character of lands by its inspectors and examiners, copies of decisions rendered by the Department of the Interior, and copies of withdrawals and restorations recommended by the Bureau of Reclamation. Within the same period 12,636 letters were prepared by the branch. These figures show an average of 49 incoming letters and of 41 outgoing letters for each working day of the year, and an increase over the preceding year of between 8 and 9 per cent in volume of work.

SUMMARY OF CASES

The information supplied concerning land classification is furnished either in reports made in response to specific requests for action on cases presented or in the form of broad areal classifications. The following table, which gives a summary of the cases presented and acted on during the year, shows that reports were made on nearly 15,000 specific requests. The mere number of cases disposed of, however, is not a true index to the magnitude of the work done, for some cases require only a few minutes' consideration, whereas others require exhaustive study and research, extending over days or weeks, and some necessitate field investigations. The terms "gain" and "loss" in the table signify, respectively, decrease and increase in the number of cases pending.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1924-25						Record since receipt of first case	
	Pending July 1, 1924	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1925	Gain or loss during fiscal year	Received	Acted on
General Land Office requests:								
General	229	1,186	1,415	1,280	135	+94		
Oil development		990	990	867	123	-123	990	867
Applications for classification as to mineral							3	3
Coal	9	6	15	12	3	+6	782	759
Oil	177	1,079	1,256	1,172	84	+83	4,352	4,268
Phosphate	2	2	4	4		+2	35	35
Applications for mineral permits	1,207	5,337	6,544	6,241	303	+904	32,673	32,370
Applications for mineral leases	20	144	164	150	14	+6	851	837
Applications for patent, potassium	1	51	52	52		+1	68	68
Federal Power Commission cases:								
Preliminary permits	1	5	6	3		-2	51	48
Licenses	1		1		1		12	11
Determinations under section 24		27	27	20	7	-7	88	81
Applications for reclassification as to water resources	7	4	11	8	3	+4	638	635
Applications for rights of way	32	186	218	189	29	+3	5,621	5,592
Irrigation project reports	4	9	13	7	6	-2	889	883
Applications under enlarged-homestead acts	341	486	827	632	195	+146	55,393	55,198
Applications under stock-raising homestead act	1,837	3,303	5,140	3,711	1,429	+408	112,585	111,156
Applications under ground-water reclamation act	37	52	89	62	27	+10	804	777
Indian Office requests for information	1	5	6	5	1		9,495	9,494
Cases in national forests		6	6	6			299	299
	3,906	12,878	16,784	14,421	2,363	+1,543		

DIVISION OF MINERAL CLASSIFICATION

The work of the division of mineral classification involves the withdrawal, classification, and restoration of public lands according to their mineral character; the solution of geologic and economic problems arising in connection with the leasing of mineral lands; and the preparation of reports concerning the mineral character of specific lands for the information and guidance of other Government bureaus charged with the administration of the public-land and Indian land laws.

The approval of the potash-land leasing act in October, 1917, and of the general mineral-land leasing act in February, 1920, opened to disposition the deposits of coal, oil, gas, phosphate, oil shale, sodium, and potash in some 50,000,000 acres that were then embraced in outstanding mineral-land withdrawals, but it did not obviate the necessity for the classification of these lands and their restoration to the public domain. To this unfinished task the mineral division is devoting as much energy as is permitted by the limitations imposed by small personnel, inadequate geologic information, and pressure of more urgent work. The results accomplished in the fiscal year include a net decrease of 509,729 acres in the total area of outstanding coal withdrawals, with a net increase of 159,040 acres in the total area classified as coal land; a net decrease of 55,418 acres in the total area of outstanding petroleum withdrawals, with a net increase of 25,640 acres in the total area classified as oil and gas land; and a net decrease of 334,941 acres in the total area of outstanding phosphate withdrawals, with a net increase of 4,690 acres in the total area classified as phosphate land. Oil-shale withdrawals were increased to the extent of 27,880 acres, in part at the request of the Department of the Navy, and the total area of classified oil-shale land was reduced 800 acres on evidence of nonshale character disclosed by detailed investigations of specific tracts by the field service of the General Land Office.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications June 30, 1925, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash (with-drawn)
	With-drawn	Classified as coal land	With-drawn	Classified as oil land	With-drawn	Classified as oil-shale land	With-drawn	Classified as phosphate land	
Alaska.....		56,903							
Arizona.....	139,415		230,400						
Arkansas.....		61,160							
California.....	17,603	8,720	1,178,392						90,518
Colorado.....	4,241,477	3,174,422	218,997		64,560	952,239			
Florida.....							84,362	120	
Idaho.....	4,761	4,603					396,612	268,299	
Louisiana.....			466,990	4,191					
Montana.....	8,160,273	8,418,643	1,350,426	67,651			279,944	3,833	
Nevada.....	83,673				123				39,422
New Mexico.....	5,157,782	568,084							
North Dakota.....	5,954,364	11,178,286	84,894						
Oregon.....	4,361	18,887							
South Dakota.....		250,093							
Utah.....	4,056,520	1,252,589	1,870,627		91,464	2,704,235	301,945	160	
Washington.....	691,801	141,444							
Wyoming.....	2,347,039	6,740,907	545,737			460,103	992,969	25,293	
	30,859,069	31,874,831	5,946,463	71,842	156,147	4,116,577	2,055,832	297,705	129,940

The contributions made to the administration of the mineral-land leasing laws with respect to coal involve the determination whether a prospecting permit or a lease should be issued, and, if a lease is

required, the establishment of a leasing unit consistent in area and content of coal with the mining operation to be undertaken and the recommendation of appropriate stipulations as to royalty, minimum investment, and minimum annual production. Those made with respect to oil and gas involve the definition of the "known geologic structure" of producing oil or gas fields as the primary distinction between leasing and prospecting areas, the determination of the structural relations of lands embraced in prospecting permit applications, and the classification of all tracts included in such applications that are involved in unperfected entries under the nonmineral-land laws. During 1924 their scope was extended to include determinations of the status and effect of drilling on or near lands involved in oil and gas prospecting permits as the basis for appropriate action on permit extensions, relinquishments, and cancellations. Similar types of service involving decisions based on geologic evidence are rendered in the administration of the potash-land leasing law and of the sections of the general mineral-land leasing law pertaining to phosphate, oil shale, and sodium.

The following table summarizes the results of the year's work to the extent that they involve the consideration of specific applications for permit or lease rights under the leasing laws:

Applications received, acted on, and pending under the mineral-leasing acts, fiscal year 1924-25

Mineral	Permits			Leases			Patents		
	Re- ceived	Acted on	Pend- ing	Re- ceived	Acted on	Pend- ing	Re- ceived	Acted on	Pend- ing
Oil and gas.....	5,041	6,000	212	27	27	1			
Coal.....	149	170	15	110	114	12			
Phosphate.....				1	3				
Sodium.....	17	16	1	2	2				
Potassium.....	130	55	75	4	3	1	51	52	
Oil shale.....					1				

Aside from that summarized above the work done under the leasing laws was restricted almost entirely to the designation of boundaries of the "known geologic structure" of producing oil and gas fields—that is, the designation of lands that are subject to lease only as distinguished from those on which prospecting permits may be granted. The results include definitions of the Wheeler Ridge field, Calif.; the Garmesa field, Colo.; the Elk Basin field, Mont.; the East, Middle, and West Red River fields, Okla.; the Cisco and Virgin River fields, Utah; the Black Mountain, Lamb, East and West Warm Springs, Elk Basin, and North, Middle, and South Baxter Basin fields, Wyo.; two extensions of the Buena Vista Hills fields, Calif.; and one extension of the Elk Basin field, Wyo.; a revision of the outstanding definition of the McKittrick field, Calif.; and cancellation of the definition of the Dry Piney field, Wyo., promulgated in 1920.

Reports made in response to requests of the General Land Office and the Office of Indian Affairs for information concerning the mineral character of specific lands have been kept essentially current.

The broader phases of the work done include the planning and financing of field surveys, both reconnaissance and detailed, which were made by the geologic, topographic, and Alaskan branches.

The larger items of field work thus undertaken during the year to meet the specific needs of the land-classification branch and financed in whole or in part by allotments from funds appropriated for the classification of lands include (1) general geologic investigations in Routt and Moffatt counties, Colo., in the western part of the Wasatch Plateau, Utah, and in the Alaska Peninsula, Alaska; (2) coal investigations in Blaine and Fergus counties, Mont., and in the Tongue River-Sheridan district, on the Montana-Wyoming boundary; in the Book Cliffs of eastern Utah; in Mesa County, Colo.; and in the White Oaks field, N. Mex.; (3) oil and gas investigations in the Elk Hills, Wheeler Ridge, Poso Creek, and Ventura County regions and on San Nicolas Island, off the coast of Santa Barbara County, Calif.; in northeastern Colorado; in the Artesia and Bloomfield-Aztec districts, N. Mex.; in the San Rafael Swell, Cisco, and Thompson districts, Utah; in the Laramie Basin, Dry Piney, and Black Hills districts, Wyo.; in the Lake Charles, Urania, Cotton Valley, and Homer districts, La.; and in the Red River district, Okla.; (4) oil-shale investigations in the Uinta Basin, Utah; (5) phosphate investigations in southwestern Montana; (6) potash investigations in the Marysvale and Salduro desert regions, Utah; and (7) miscellaneous investigations of individual cases in other parts of the public domain.

DIVISION OF HYDROGRAPHIC CLASSIFICATION

POWER SECTION

The work of the power section consists primarily in obtaining and making available for use in the administration of the public-land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public-land law. An endeavor is made to determine the proper administrative action by which the possibility of developing power may be preserved with minimum interference with agricultural, transportation, or other interests. In the course of this work a review of all power reserves is carried on, in order that all land having primary value for the development of power, and only such land, shall be reserved for that purpose. The extent of this task is indicated by the fact that areas aggregating more than 5,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the field branches of the Survey. The larger items of field work done to obtain information for power classification undertaken and in progress during the year at the request of the land-classification branch and financed by allotments from funds appropriated for the classification of lands include (1) plan and profile surveys and

power-site investigations on Clearwater and Payette rivers and their principal tributaries in Idaho; on Coquille, Umpqua, and Siletz rivers and their principal tributaries in Oregon; on San Rafael River and on streams in the Uinta River basin, Utah; and on Eel River in California; (2) detailed studies of the possibilities of developing power on Colorado River and its tributaries, including Blue, Dolores, Eagle, Roaring Fork, San Miguel, and Taylor rivers in Colorado and San Juan River in Colorado, New Mexico, and Utah; and (3) studies leading to the preparation of reports for publication on water utilization on Green River, upper Colorado River, and Colorado River below the mouth of the Green.

The information obtained is indexed and incorporated in an inventory of water resources, which, when complete, will enable the Survey to give competent advice on short notice as to the manner in which each tract of public land having value for power can be best used in connection with the development of water power and as to the relation of such use to other possible uses of the tract. Copies of many of the reports made on the power possibilities of the streams examined have been placed in the district offices of the Survey for public inspection, and notices of the availability of the reports have been sent to the press.

The work done in the section is briefly summarized in the following tables showing power-site reserves, outstanding water resources, and agricultural withdrawals and classifications, and in the table on page 76, giving a general summary of cases involving land classification.

Pursuant to the instructions of the Secretary of the Interior dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted by the Secretary since January 1, 1913, were called upon for detailed reports of the operation or development of their power systems during the calendar year 1924. The total installation of the reporting companies is 1,740,000 kilowatts, of which 1,320,000 kilowatts is installed at hydraulic plants. The total energy generated amounted to 6,100,000 kilowatt-hours, of which nearly 5,000,000 kilowatt-hours was generated by water power.

Power output of permittees and grantees, 1916-1924

Year	Number reporting	Kilowatt-hours	Increase or decrease	
			Kilowatt-hours	Per cent
1916	26	1,200,000,000		
1917	32	2,000,000,000	+800,000,000	+67
1918	51	3,200,000,000	+1,200,000,000	+60
1919	57	3,100,000,000	-100,000,000	-3
1920	56	4,200,000,000	+1,100,000,000	+35
1921	59	3,725,000,000	-475,000,000	-11
1922	59	4,947,000,000	+1,222,000,000	+33
1923		5,910,000,000	+963,000,000	+19
1924		6,100,000,000	+184,000,000	+3

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1053). Designations, classifications, and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1924	Eliminated prior to July 1, 1924	Reserves outstanding prior to July 1, 1924	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1925
Alabama.....	749		749	36		785
Alaska.....	168,508	520	167,988	42,712		210,700
Arizona.....	1,163,163	113,194	1,049,969	100,632		1,150,601
Arkansas.....	28,551		28,551			28,551
California.....	995,354	19,259	976,095	38,146	6,323	1,007,918
Colorado.....	353,509	55,133	298,376	126,125	15,376	409,125
Florida.....	486		486			486
Idaho.....	450,879	184,220	266,659	515	2,000	265,174
Michigan.....	1,240		1,240			1,240
Minnesota.....	12,889	532	12,357	400		12,757
Montana.....	299,632	84,802	214,830	3,035	8,977	208,888
Nebraska.....	761		761			761
Nevada.....	300,750	480	300,270			300,270
New Mexico.....	215,181	7,633	207,548	55,697		263,245
Oregon.....	552,485	85,248	467,237	25,208	400	492,045
South Dakota.....	12		12			12
Utah.....	591,718	123,040	468,678	79,677	74	548,281
Washington.....	201,388	50,207	151,181	47,644	2,603	196,222
Wisconsin.....	1,086	226	860	114		984
Wyoming.....	222,395	73,408	148,987	148		149,135
	5,560,746	797,902	4,762,844	520,089	35,753	5,247,180

*Summary of outstanding water-resources withdrawals and classifications
June 30, 1925, in acres*

State	Power reserves					Reservoir withdrawals	Public water withdrawals	Ground water reclamation designations
	With-drawals	Classifi-cations	Designa-tions *	Miscel-laneous	Total			
Alabama.....	120	190		475	785			
Alaska.....	93,415	43,005		74,280	210,700			
Arizona.....	395,283	37,182	528,245	189,891	1,150,601	23,040	14,796	
Arkansas.....	22,354	1,590		4,607	28,551			
California.....	291,980	84,526		631,412	1,007,918	1,160	167,511	
Colorado.....	237,184	136,853		35,088	409,125	1,728	1,660	
Florida.....				486	486			
Idaho.....	210,936	47,229		7,009	265,174		12,355	
Michigan.....	1,240				1,240			
Minnesota.....	12,309			448	12,757			
Montana.....	132,544	53,379		22,965	208,888	9,080	7,457	
Nebraska.....	761				761			
Nevada.....	27,492	27,786		244,992	300,270		10,086	1,550,420
New Mexico.....	120,084		143,161		263,245		8,316	
North Dakota.....						1,569		
Oklahoma.....								
Oregon.....	394,815	24,356	15,891	56,983	492,045	10,619	17,781	
South Dakota.....				12	12		240	
Utah.....	445,008	81,017		22,256	548,281	80	33,350	
Washington.....	97,751	49,961		48,510	196,222	35,943	920	
Wisconsin.....				984	984			
Wyoming.....	82,829	25,621		40,685	149,135	1,714	80,665	
	2,566,105	612,695	687,297	1,381,083	5,247,180	84,933	355,137	1,550,420

* Designated and not otherwise withdrawn for power purposes.

IRRIGATION SECTION

The work of the irrigation section includes the classification of lands under the enlarged and stock-raising homestead laws as non-irrigable; the classification of lands under the Nevada ground-water reclamation act as nontimbered and not known to be susceptible of

successful irrigation; the preparation of reports on the sufficiency of the water supply and general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public-land laws; and the initiation of withdrawal of lands for reservoir sites. Applications for classification are disposed of according to the results of examination made by the field branches of the Survey and information gathered from other sources showing water supply and adaptability to irrigation. Many applications involve the classification of large areas, and such broad classifications serve to govern action on new applications for the classification of land in the same areas. Thus broad field studies are planned in critical areas for execution by the field branches and financed by allotments from the funds appropriated for the classification of lands. During the year such studies were in progress in Casa Grande Valley, Ariz.; Salton Sink basin, Calif.; and Escalante Valley, Utah. Additional field studies were undertaken in scattered small tracts throughout the public-land States.

During the year the area of land designated under the Nevada ground-water reclamation act as a result of the work of the section was increased from 1,425,060 to 1,550,420 acres. On the basis of general field studies, withdrawals creating reservoir site No. 8 on Grape Creek, Colo., and reservoir site No. 27 on Red Rock River, Mont., were canceled. These withdrawals, embracing a total area of 11,530 acres, were created under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection made by the Director of the Geological Survey February 27, 1891. Other results of the work are shown briefly in the tables relating to enlarged and stock-raising homestead designations and general summary of cases.

Summary of enlarged-homestead designations, in acres

[Areas classified as arid and nonirrigable, residence by entrymen required (acts of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; June 17, 1910 (36 Stat. 531), applicable to Idaho; June 13, 1912 (37 Stat. 132), applicable to California, North Dakota; Mar. 3, 1915 (38 Stat. 953), applicable to Kansas; Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (acts of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; June 17, 1910 (36 Stat. 531), applicable to Idaho)]

State	Designations prior to July 1, 1924	Cancellations prior to July 1, 1924	Designations outstanding prior to July 1, 1924	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1925
Arizona.....	31, 246, 649	5, 409, 594	25, 937, 055	54, 015	20, 160	25, 970, 910
California.....	13, 179, 774	238, 453	12, 941, 321	7, 659		12, 948, 980
Colorado.....	33, 396, 086	184, 968	33, 211, 098	184, 635	10, 530	33, 385, 213
Idaho:.....						
Total.....	13, 541, 228	458, 125	13, 083, 103	62, 610	* 2, 780	13, 142, 933
Nonresidence.....	569, 627	4, 233	565, 394	3, 120		568, 514
Kansas.....	646, 034		646, 034	1, 890		647, 914
Montana.....	53, 304, 955	245, 728	53, 059, 227	40, 250		53, 099, 477
Nevada.....	50, 120, 150	3, 594, 797	46, 555, 353			46, 555, 353
New Mexico.....	43, 717, 245	227, 732	43, 489, 513	8, 980		43, 498, 493
North Dakota.....	12, 271, 105	3, 848	12, 267, 257	2, 907		12, 270, 164
Oregon.....	21, 254, 734	989, 462	20, 265, 272	1, 590	440	20, 266, 422
South Dakota.....	16, 330, 588	348, 170	15, 982, 418	3, 223		15, 985, 641
Utah:.....						
Total.....	11, 332, 240	392, 215	10, 940, 025	83, 394	* 16, 394	11, 007, 025
Nonresidence.....	1, 624, 380	22, 800	1, 601, 580	15, 714	5, 480	1, 611, 814
Washington.....	6, 635, 400	251, 842	6, 383, 558	11, 192		6, 394, 750
Wyoming.....	29, 338, 407	161, 764	29, 176, 643	72, 634		29, 249, 277
	330, 414, 595	12, 476, 718	323, 937, 877	534, 869	50, 274	324, 422, 877

* Previously designated under secs. 1-5, now designated under sec. 6.

* Includes 6,874 acres previously designated under secs. 1-5, now designated under sec. 6.

DIVISION OF HOMESTEAD CLASSIFICATION

The provisions of the stock-raising homestead law are applicable to lands the surface of which is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of irrigation from any known source of water supply, and is of such a character that 640 acres is reasonably required for the support of a family.

The division of homestead classification acts on petitions for classification of lands under this act except as to the nonirrigability of the land, which is determined by the irrigation section in the division of hydrographic classification. The work of the division is performed on the basis of records available to the Survey and data obtained through field studies which are planned by the division and financed with funds appropriated for the classification of lands. Usually the field studies are planned for the purpose of obtaining data needed in order to classify lands involved in pending applications for stock-raising homesteads, but where practicable the scope of the field studies includes broad regional investigations to obtain information for action on future cases. The number of individual cases received and acted upon is shown in the general summary of cases.

Under instructions of the Secretary of the Interior the division is cooperating with the Department of Agriculture in preparing a report on the agriculture and the utilization of land in the northern Great Plains region and completed four atlas sheets showing land classification in that region during the year.

The following summary of stock-raising homestead designations shows in detail other features of the progress of the work of this division, which has been kept substantially current throughout the year.

Summary of stock-raising homestead designations, in acres

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family. Act of Dec. 29, 1916 (39 Stat. 862)]

State	Designations prior to July 1, 1924	Cancellations prior to July 1, 1924	Designations outstanding prior to July 1, 1924	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1925
Arizona.....	13,867,422	832,200	13,035,222	28,961	19,520	13,044,663
Arkansas.....	1,120		1,120			1,120
California.....	7,619,863		7,619,863	100,529	760	7,719,632
Colorado.....	7,948,205	9,240	7,938,965	203,835	9,480	8,133,320
Florida.....				480	480	
Idaho.....	5,146,021	1,774	5,144,247	116,661		5,269,908
Kansas.....	109,299		109,299	4,200		113,499
Michigan.....	3,451		3,451			3,451
Montana.....	14,821,256	17,081	14,804,175	202,030		15,006,205
Nebraska.....	162,034		162,034	21,460		183,494
Nevada.....	470,940	2,800	468,140	27,608		495,748
New Mexico.....	30,999,526	600	30,998,926	140,228	36	31,139,118
North Dakota.....	363,185		363,185	1,670		364,855
Oklahoma.....	73,201		73,201	3,059		76,260
Oregon.....	6,143,253	2,408	6,140,845	73,159	80	6,213,924
South Dakota.....	6,454,674	550	6,454,124	14,240		6,468,364
Utah.....	1,177,230	880	1,176,350	173,357		1,349,707
Washington.....	648,083	1,134	646,949	25,602		672,611
Wyoming.....	19,651,230	5,014	19,646,216	162,758	40	19,808,934
	115,659,993	873,681	114,786,312	1,299,897	30,396	116,055,813

The work of this division includes also the reservation and restoration of tracts valuable for watering stock. During the year the additions to public water reserves embraced 370 acres in Arizona, 180 acres in California, 275 acres in Idaho, 160 acres in Montana, 1,830 acres in Oregon, and 240 acres in Utah, and the cancellations of such reserves included 220 acres in Arizona, 40 acres in California, 80 acres in Colorado, 375 acres in Utah, and 840 acres in Wyoming. The areas remaining reserved as public watering places at the end of the year are shown in the table of outstanding water-resources and agricultural withdrawals and classifications.

PUBLICATION BRANCH

DIVISION OF BOOK PUBLICATION

SECTION OF TEXTS

During the year 20,372 pages of manuscript were edited and prepared for printing, and proof sheets comprising 2,052 galley proofs and 15,011 page proofs were read and corrected. Indexes were prepared for 46 publications, covering 9,689 pages. Copy and proof or stencils for 535 pages of multigraph and mimeograph matter were read. The book publications of the year are listed and abstracted on pages 6-14.

At the end of the fiscal year five persons were employed in this section. The water-resources branch has continued to render special assistance in preparing copy and reading proof.

On June 30, 1925, G. M. Wood, who was appointed in 1889 and had been editor since July 1, 1908, was retired on account of age. The Geological Survey's editorial work under Mr. Wood has been widely recognized as being on a plane unattained elsewhere in the Government service.

SECTION OF ILLUSTRATIONS

The number of drawings prepared was 3,099, including 133 maps, 993 sections and diagrams, 437 photographs, and 1,536 paleontologic drawings; 132 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany manuscripts numbered 948, to be reproduced by chromolithography, photolithography, halftone, zinc etching, and cuts already engraved. The number of proofs received and examined was 749. At the end of the year material for illustrating 30 reports was on hand. The section now consists of eight employees.

DIVISION OF MAP EDITING

SECTION OF GEOLOGIC EDITING OF MAPS AND ILLUSTRATIONS

During the year the Central Black Hills folio (No. 219) and the geologic map of Wyoming were completed and published. The geologic map of Arizona was also completed and printed under the direction and supervision of this section but published by the State Geological Survey. The Gillespie-Mount Olive (Ill.) and Bessemer-Vandiver (Ala.) folios were prepared for publication, and the maps of the former were engraved and made ready for transfer to stone.

The Gaffney-Kings Mountain (N. C.-S. C.), Hollidaysburg-Huntingdon (Pa.), and Montevallo-Columbiana (Ala.) folios were also received for publication during the year, and their preparation was well advanced. The geologic map of New Mexico was prepared for publication and photolithographed, and color work is in progress. The geologic map of Oklahoma was drawn and a preliminary photolithograph made, but it has not yet reached the publication stage. Compilation of the geologic map of Texas progressed slowly. Compilation of the geologic maps of Pennsylvania and Arkansas for publication by the respective State surveys was begun, and that of Pennsylvania was well advanced. Illustrations for 40 other reports of the Survey were critically examined and edited. Maps, sections, and other illustrations for geologic folios and reports were also drawn in the section.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

During the year 58 topographic maps were edited and transmitted for engraving, 169 published topographic maps were edited for reprint, 63 plan and profile river-survey sheets were edited for photolithography, 2 miscellaneous maps were edited for engraving or photolithography, and 190 maps were edited as illustrations for Survey reports, a total of 482 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 459 and proofs of maps reproduced by photolithography numbering 235 were read. At the end of the year 66 new topographic maps were in process of engraving and printing. Index maps for 16 State circulars were revised and proofs corrected. (See also "Topographic branch," p. 59.)

DIVISION OF DISTRIBUTION

During the year the division received 184 new books and pamphlets, 2 reprinted books and pamphlets, 1 new geologic folio, 3 new geologic maps, 128 new or revised topographic and other maps, and 158 reprinted topographic and other maps. The total units of all publications received numbered 512,994 books and pamphlets, 2,970 geologic folios, 3,770 geologic maps, and 765,323 topographic and other maps, a grand total of 1,285,057.

The division distributed 650,842 books, 10,027 folios, and 729,154 maps, a total of 1,390,023, of which 603,711 maps and 8,305 folios were sold. The sum received and deposited in the Treasury from the sale of publications was \$42,305.62, including \$39,797.68 for topographic and geologic maps and \$2,507.94 for geologic folios. In addition, \$1,124.45 was paid by other establishments of the Federal Government for maps or folios furnished by request. The total receipts, therefore, were \$43,430.07. The division received and answered 94,104 letters.

At the end of the year the division comprised 16 employees.

DIVISION OF ENGRAVING AND PRINTING

At the end of the fiscal year the division of engraving and printing comprised 99 employees.

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the fiscal year 82 new topographic maps were engraved and printed, including 5 revised maps; also the new sheet of standard symbols. Forty-four new maps and a new edition of the Wyoming 1:500,000 scale map were photolithographed and printed, making a total of 128 new maps printed and delivered. Corrections were engraved on the plates for 143 maps. Reprint editions of 150 topographic maps and photolithographed editions of 8 corrected State and other maps were delivered. In addition 28 new topographic maps were engraved but had not been printed by June 30, and the engraving for 10 more new topographic maps was nearly completed. Of new and reprinted maps, 286 different editions, amounting to 765,323 copies, were delivered. Two new geologic folios were printed, in editions amounting to 2,970 copies. Extra maps of these folios, numbering 3,770 copies, were also delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, Office of the Secretary of the Interior, Bureau of Mines, Bureau of Reclamation, Bureau of Education, National Park Service, Office of Indian Affairs, General Land Office, Bureau of Public Roads, Bureau of Agricultural Economics, Forest Service, Agricultural Extension Service, Weather Bureau, Bureau of Standards, Bureau of Lighthouses, Bureau of American Ethnology, Internal Revenue Bureau, Department of Labor, Department of State, War Department, Navy Department, Post Office Department, Treasury Department, Department of Commerce, Interstate Commerce Commission, Federal Power Commission, International Boundary Commission, Commission of Fine Arts, Alaska Railroad, Public Buildings Commission, Federal Trade Commission, Civil Service Commission, Commission of Gold and Silver Inquiry, Federal Board for Vocational Education, Veterans' Bureau, War Finance Corporation, and the District of Columbia Engineer Department. This work done for other branches of the Survey and the Government included many reprints, and the charges for it amounted to about \$135,342, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the Treasury Department. Work amounting to \$12,241.91 was done for various State surveys, and payment was effected by transferring employees from Federal to State pay rolls. Transfer impressions numbering 278 were made during the year, including 104 furnished to contracting lithographic printers on requisition of the Government Printing Office, 141 furnished to private firms, 8 furnished to the Connecticut State Highway Commission, and 25 furnished to the War Department. Other miscellaneous work was done for the Williams-Webb Co., A. Hoen & Co., the Bartlett-Orr Press, Joseph Hyde Pratt, the Pennsylvania Department of Forests and Waters, Walter Gilliss, and the City of St. Louis. The amount turned over to miscellaneous receipts from this work was \$300.80.

Of contract and miscellaneous work of all kinds 2,955,326 copies were printed. Including topographic maps and geologic folios, a grand total of 3,727,389 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 12,435 negatives (5,407 wet, of which 4,276 were for photolithographs, 188 paper, 1,938 dry, and 4,902 field negatives developed), 756 lantern slides, 78,958 prints (52,745 maps and diagrams, 22,830 photographs for illustrations, and 3,383 rectigraphs), 3,951 zinc plates, 202 zinc etchings, 86 celluloid prints, 130 lantern slides colored, 15 bromide prints colored, and 728 prints mounted.

ADMINISTRATIVE BRANCH

Col. Henry C. Rizer, chief clerk, retired at the end of February, and John J. Madigan was appointed to the position.

EXECUTIVE DIVISION

The work of the executive division was of the same general character as during the fiscal year 1924, although the duplicating section was transferred to the Secretary's office in connection with the consolidation of duplicating work in the department in February.

During the year 130,666 pieces of mail, of which 2,598 were registered, were opened and referred; besides 1,500 letters and cards received in connection with revisions of mailing lists. In addition, 180,766 letters were received direct by the other divisions, making a total of 322,932, a decrease of 7 per cent compared with 1924. Of the letters opened in this division 20,151 contained \$32,475.82 remitted for Survey publications. The number of ordinary letters mailed through the division was 87,594, of registered letters and packages 13,369, and of form letters, etc. (addressograph section), 660,000. In addition, 251,428 pieces of mail were sent direct from other divisions. The total number of outgoing pieces of mail for the Geological Survey was 912,391.

During the year 2,710 pieces of freight and express were handled, 1,370 outgoing and 1,340 incoming.

The roll of Secretary's appointees numbered 834 at the end of the fiscal year, 94 less than at the end of 1924. The total number of changes in personnel was 601, which included 76 appointments, 170 separations, and 455 miscellaneous changes.

During the calendar year 17,635 days of annual leave and 3,900 days of sick leave were granted—75 per cent of the amount of annual leave and about 12 per cent of the amount of sick leave it would have been possible to grant. Leave without pay and furloughs amounted to 3,118 days.

The clerical personnel of the division at the end of the year numbered 13, including 3 assigned to the consolidated duplicating section. This is a reduction of 17, 9 of whom were transferred through the consolidation of the duplicating work under the Secretary's office. In addition, there were 2 general laborers, 1 chief messenger, and 10 messengers.

DIVISION OF SCIENTIFIC AND TECHNICAL EQUIPMENT

The division of scientific and technical equipment received 1,054 requisitions during the year, of which 1,005 were completed. The

work consisted of the repair of numerous instruments, inspection and repair of electric motors, fans, etc., cabinet work of many kinds, and miscellaneous manufacturing and repair work incident to engineering and scientific research.

LIBRARY

The accessions to the library numbered 13,618 books, pamphlets, and periodicals and 597 maps. The recorded loans were 6,830 books and 233 maps, not including those used by 13,026 readers who consulted the library in person. Some of the loans were made to libraries and institutions in Washington and other cities. The catalog was increased by the addition of 4,436 cards. In accordance with the cooperative cataloging arrangement 504 title entries were furnished to the Library of Congress for printing.

The correspondence, consisting of 1,991 letters written and 2,076 received, largely concerned the exchange of publications; this correspondence involved the translation of many letters in foreign languages. Foreign articles and letters translated for other divisions of the Survey numbered 243. There were 626 books collated and prepared for binding, and 324 newly bound books accessioned and labeled.

Cooperation was continued in the compilation of a union list of serials available in the libraries of the United States, to be published under the auspices of the American Library Association.

The preparation of the bibliography of North American geology for the years 1923 and 1924 was continued.

DIVISION OF ACCOUNTS

Condensed statements covering the expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

GEORGE OTIS SMITH,
Director, Geological Survey.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1926.

Appropriation	Funds available					Expenditures		Balance	
	Amount of appropriation	Repayments on account of work performed			Total	Disbursements	Outstanding liabilities		Total
		For other Government establishments		For other Geological Survey units					
		Made	To be made						
Salaries.....	\$54,700.00			\$100.00	\$54,800.00	\$54,625.99		\$54,625.99	\$274.01
Topographic surveys.....	501,480.00	\$17,604.46	\$2,179.09	21,990.35	543,253.90	537,263.69		540,754.11	2,499.79
Geologic surveys.....	335,562.00	1,177.96	638.36	411.30	337,789.61	332,892.50	3,511.38	335,370.88	1,418.93
Chemical and physical researches.....	40,000.00				40,000.00	39,470.02	403.02	39,873.04	126.96
Preparation of illustrations.....	18,000.00	13.33			18,013.33	17,968.87		17,968.87	24.46
Mineral Resources of the United States.....	127,940.00	154.92		175.00	128,269.92	126,812.23	669.19	127,468.43	771.59
Mineral Resources of Alaska.....	75,000.00	136.27			75,136.27	57,866.96	16,065.71	73,931.68	1,204.59
Gaging streams.....	191,135.00	28,266.12	5,738.40	2.96	225,142.47	218,409.96	911.31	219,321.27	5,821.20
Geologic maps of the United States.....	110,000.00	94,798.78	13,387.77	22,732.75	240,919.30	234,822.70	4,409.96	239,232.68	1,686.62
Classification of lands.....	261,546.00	1,179.34	25.24	250.46	263,001.04	277,450.97	4,162.83	261,613.79	1,367.25
	\$1,735,423.00	143,331.17	21,969.06	45,662.81	\$1,946,386.04	\$1,897,099.90	33,510.83	\$1,931,210.73	15,175.31

* In addition to these appropriations, items of \$110,000 for printing and binding Survey publications and \$10,000 for miscellaneous printing and binding were contained in the appropriation act, but the accounts for these items were not kept in the Geological Survey. There was also an allotment of \$4,944.75 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

* Included in this amount is \$28,941 appropriated for adjustment of field salaries.

* Included in this amount is \$45,662.81 covering work performed by Survey units for other Survey units, necessarily reported in combining totals, but otherwise a duplication.

* Of this total, \$5,959.08 is in the hands of special disbursing agents and therefore has not been included in the classification of expenditures, as no vouchers covering disbursements have been received.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1925

Object of expenditure	Geological survey salaries	Topo- graphic surveys	Geologic surveys	Chemical and physical researches	Prepara- tion of illustra- tions	Mineral resources of the United States	Mineral resources of Alaska	Gaging streams	Geologic maps of the United States	Classifica- tion of lands	Total
Personal services.....	\$54,625.99	\$401,689.87	\$292,590.23	\$84,882.85	\$17,716.25	\$121,147.92	\$45,288.72	\$186,603.61	\$183,063.75	\$219,225.41	\$1,556,834.60
Stationery and office supplies.....	2,334.53	2,334.53	604.19	61.30	16.61	185.80	212.24	1,462.88	33,062.72	638.27	39,193.93
Scientific and educational supplies.....	333.60	333.60	935.36	1,496.68	16.61	21.24	83.38	227.13	---	263.86	3,880.86
Sundry supplies.....	2,470.22	2,470.22	1,344.78	39.31	---	16.09	163.18	708.07	6,816.25	773.55	12,391.45
Subsistence and care of animals and storage and care of vehicles.....	1,444.10	690.04	690.04	---	---	12.00	---	---	---	---	2,156.14
Telephone service.....	599.60	201.20	201.20	2.90	25	949.15	95.01	194.57	4.47	76.03	2,143.18
Telephone service.....	133.80	133.80	13.23	2.90	---	203.04	---	397.48	---	155.40	907.55
Other communication service.....	13.75	13.75	50	---	---	---	---	8.00	---	6.15	28.40
Travel expenses.....	65,925.08	18,434.83	18,434.83	978.82	---	3,132.95	8,841.57	11,440.05	60.74	32,012.56	140,837.58
Attendance at meetings.....	54.74	1,641.33	1,641.33	---	---	36.91	---	288.39	---	---	2,021.37
Hire, maintenance, operation, and repair of horse-drawn and motor-propelled passen- ger-carrying vehicles.....	6,539.73	1,953.51	1,953.51	---	---	204.68	57.00	2,671.17	---	5,887.00	17,265.07
Transportation of things.....	26,072.89	2,868.06	2,868.06	542.09	79	256.30	2,684.05	1,564.16	24.59	8,018.72	42,977.25
Lithographing, engraving, and engrossing.....	1,260.18	1,566.86	1,566.86	16.43	148.81	179.65	86.73	921.96	4.68	1,613.91	5,789.23
Stanographic work, typewriting, and dupli- cating work, etc. (Job work).....	13.30	13.30	13.30	---	---	40.00	---	1.22	---	46.30	114.32
Photographing and making photographs and prints.....	810.29	4,423.78	4,423.78	225.65	104.96	119.38	7,445.97	755.26	---	2,036.71	15,921.00
Rents.....	10.00	11.50	11.50	---	---	---	6.00	1,980.00	---	---	2,008.50
Repairs and alterations.....	25.14	57.44	57.44	---	---	---	16.16	158.35	1,082.50	46.59	1,386.18
Special and miscellaneous current expenses.....	9,266.08	4,063.59	4,063.59	697.19	1.20	831.34	839.63	1,003.83	6,591.73	4,676.02	27,990.61
Purchase of passenger-carrying vehicles.....	1,895.00	990.00	990.00	---	---	---	---	3,894.16	---	2,790.75	9,539.91
Furniture, furnishings, and fixtures.....	1,071.91	1,823.90	1,823.90	25.00	---	---	992.82	1,161.99	---	192.34	3,234.61
Educational and scientific equipment.....	93.00	---	---	898.27	---	137.99	335.81	2,684.73	75.83	178.63	7,209.06
Livestock.....	---	---	---	---	---	---	792.00	---	---	40.00	925.00
Other equipment.....	17,994.69	859.23	859.23	---	---	---	82.73	1,133.30	7,806.42	3,028.59	30,904.96
	54,625.99	840,754.11	336,370.88	39,873.04	17,988.87	127,498.42	67,972.00	219,321.27	239,232.68	281,613.79	1,925,251.05

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U. S. DEPARTMENT OF THE INTERIOR

**ANNUAL REPORT OF THE
DIRECTOR OF
THE GEOLOGICAL SURVEY
TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1926**



DEPARTMENT OF THE INTERIOR
Hubert Work, Secretary

U. S. GEOLOGICAL SURVEY
George Otis Smith, Director

FORTY-SEVENTH ANNUAL REPORT
OF THE
DIRECTOR OF
THE GEOLOGICAL SURVEY
TO THE
SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1926



WASHINGTON
GOVERNMENT PRINTING OFFICE
1926

Directors of the Geological Survey

CLARENCE KING, 1879-1881
JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907
GEORGE OTIS SMITH, 1907-

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U. S. Govt.
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1-10-1927.

ANNUAL REPORT

OF THE

DIRECTOR OF THE GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
September 1, 1926.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1926 included 12 items, amounting to \$1,952,610. In addition \$85,930 was appropriated for printing the reports of the Geological Survey, and \$11,700 for miscellaneous printing and binding, and an allotment of \$6,165 for miscellaneous supplies was made from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of this report. The balance shown, including budget reserve of \$11,435, is \$48,055.73.

COOPERATION

Cooperation with the States and other public agencies continued in other years. The value of the mapping and investigative work of the Geological Survey and the necessity of expediting the completion of this physical inventory of the country's resources is now so widely recognized that 37 States as well as many counties and municipalities shared with the Federal Government in meeting the cost.

The total amount thus contributed was \$665,731.35. Funds aggregating \$213,695.39 were placed to the credit of the Geological Survey for services rendered to other Government bureaus and offices and permittees under the Federal power act. The total expenditure, measuring the amount of work accomplished during the year, was \$2,783,981.01.

SUMMARY OF THE WORK OF THE YEAR

In the itemized summary of the year's program, as given below, no emphasis is put on items that are new, nor even are comparisons made with the accomplishments of other years. Certain noteworthy items may, however, be cited as possibly illustrating the trend of the Geological Survey's investigations in the fields assigned to it by congressional authority.

Cooperation with the Geological Survey's topographic engineers has been continued by the United States Army Air Service, which has photographed approximately 7,500 square miles for use in the topographic mapping program. This has resulted in a large saving in the cost of ground surveys of areas to which aerial photography is adapted. In the present stage of development aerial photography can only supplement topographic surveys by ground methods and can not replace them to any large extent. As methods and instruments are improved, however, this new aid to ground surveys will prove a greater benefit and will result in larger savings in cost.

An expedition organized by the Bureau of Aeronautics of the Navy began aerial photographic surveys in southeastern Alaska in response to the request of the Geological Survey, indorsed by the other bureaus needing maps of this region.

Survey physicists and chemists joined the geologists in seeking to serve the oil industry in the effort to recover a larger part of the oil already found, as well as to discover new fields. Laboratory experiments of promise are being put to the test of actual field practice. Cooperation of this type is appreciated by the producers.

The technical administration of the oil and gas, coal, and other leases on the public domain has been under the Geological Survey only the past year. The principal change in policy during that period has been the placing of more authority in the field officers in the handling of technical questions, thus relieving the operating lessees from vexatious delays that might involve large expense. When the mineral leasing law was enacted the cost of administration was estimated at 10 per cent of the total receipts, but the present cost of the Geological Survey's supervisory work is only about one-fifth of that, or 2 per cent of the aggregate rents and royalties involved. Even without allowing for the services rendered to the Indian lessors the cost of supervision is but a small fraction of the actual return to the Federal Treasury, which is only 10 per cent of the total receipts, the remainder going to the States either directly or through the reclamation fund. Moreover, the future values preserved by practical conservation of this type far exceed any present returns under the leasing system.

A marked reduction in the number of publications issued and of copies distributed is due principally to the transfer of the mineral-statistics division to the Department of Commerce. In the preceding year 61 chapters were issued, each treating of a separate mineral product. The growth of this special statistical service rendered to the mineral industry has been marked since the appearance of the first annual report on mineral resources in 1883, when \$10,000 was authorized for this statistical work, as contrasted with the appropriation of \$125,000 for 1925. In that same period, however, the mineral production of the United States increased from \$454,000,000 to \$5,696,000,000; moreover, the total value of the output for the earlier year was exceeded by the value last year of four products not even mentioned in the 1883 report—natural gas, gasoline from natural gas, aluminum, and gravel. This marvelous growth of a basic industry has been faithfully recorded year by year in these volumes, which will hereafter bear the imprint of the Bureau of Mines.

As has been true for several years, the Geological Survey distributes more copies of its book publications than are currently issued, owing to the continued demand for reports issued in other years, and a further measure of this demand is afforded by the fact that fully one request in five for publications is unfilled by reason of reports being out of print. The Geological Survey type of Government publication is not accumulating on the shelves of any document room.

The map-printing plant of the Geological Survey, which last year had an appropriation of \$105,000 for engraving and printing the topographic and geologic maps, is to be credited with \$48,251.36 turned into the Treasury from the sales of maps and transfers. Ten years ago, with a slightly larger appropriation, the miscellaneous receipts from this source were \$30,369.35. Since 1920 the map sales have increased in number more than 25 per cent.

The net reduction in force during the year, as determined by comparing the payrolls of July 1, 1925, and June 30, 1926, was 72. In so far as this reduction has to do with the clerical and other employees representing purely administrative—that is, nonproductive—overhead, the smaller expenditure can be regarded as expressing a corresponding economy; but whatever reduction there has been in the technical staff indicates that there has been a corresponding loss in production, for otherwise this staff must have previously included nonworkers, which was not the case. The volume of geologic investigation, of topographic mapping, of stream measurements has always been far less than the demand, so that any decrease in output is a still greater deficiency in accomplishment of what is expected from the Geological Survey not only by the public but by the committees of Congress which specify the types of work to be carried on. To that degree any reduction in productive force is not a saving but a loss—a deficiency that must sometime be met.

Cutting in two the geologic working force of the Alaskan branch can mean nothing less than retarding the exploration of Alaskan resources; the 3 per cent reduction in the technical staff of the water-resources branch during the year and the 5 per cent reduction in the number of geologists in the geologic branch are both expected to be reflected in the volume of work accomplished, and the loss in both quantity and quality of work done will unfortunately be greater than these percentages would suggest, because the recruits to the staff lack the maturity of experience possessed by most of the technical men who leave the Geological Survey to accept educational or corporation positions. These foreseen deficiencies in results are especially to be regretted in view of the arrears already existing in the current work.

It is of course impossible to express quantitatively the unoccupied fields, the untouched problems, the unanswered requests for investigation, but for a few concrete items figures are available with which to measure the lag in current work. Thus, in the various types of land-classification cases on which technical reports are made to the Secretary of the Interior or the Commissioner of the General Land Office, the arrears at the end of the year were from two to four months; in the handling of coal and phosphate withdrawals recent progress has been so slow that a delay of many years must be expected in completing the examination and classification, and the

deficiency is even worse in the power examination of the remaining 15,000 miles of streams in the public-land States. The analytical work of the chemical laboratory is something like three months in arrears. The preparation of stream-gaging records for publication is 17 months behind. The engraving of topographic maps is 15 months from being current. The editing of texts for the printed reports is 9 months in arrears, and the preparation of illustrations was $1\frac{1}{2}$ years in arrears at the end of the year, but with the increase in force now provided this record will be considerably bettered next year. In addition to this lag in the preparation of manuscripts the printing of the reports ready for the printer may be conservatively stated as five months in arrears. With the one exception noted above no appreciable improvement in this record can be expected under present conditions, much as it is desired. The delay in making public the full results of investigations too often involves a real loss in value.

The attendance of the members of the Geological Survey shows a gratifying appreciation of the demand for increased output. The average length of the working year last year was shortened less than 25 days by the annual and sick leave actually taken. Adequate records of overtime service, for which no pay is allowed, are not available, but it is conservative to estimate that at least 3 days was added to the average year in this way, so that the year for which salary is paid includes a net loss of time not exceeding 22 days.

At the end of the year the average salary paid to the 515 members of the technical and clerical staff with headquarters in Washington was \$2,480; the mean salaries permissible for each grade under the classification act for these same employees would have averaged \$2,657.

WORK IN GEOLOGY

Made geologic surveys in 43 States and in the District of Columbia and Alaska, including geologic mapping, determination of stratigraphy, structure, and geologic history, and examination of mineral resources.

Cooperated with eight States in geologic work.

Continued detailed geologic mapping of the coal fields of the public-land States, preparing reports that show distribution of outcrops, thickness and quality of coal, and estimates of available tonnage.

Continued the examination of the metalliferous regions of the Western States, the resulting reports and maps indicating the distribution of ores and of the rock formations that contain or have caused the formation of the ore bodies.

At the request of the Colorado Metal Mining Fund, began a cooperative study of that part of Colorado that contains or may contain metalliferous minerals, with the primary purpose of aiding in the search for ore.

Continued the search in Texas, New Mexico, Colorado, and Utah for potash, through a study of the records of wells drilled usually for oil, obtaining data which prove that potash exists in several areas but which do not determine whether it is present in commercial quantities.

As a result of laboratory experiments, made suggestions to the oil operators in the Bradford field, Pa., that the usual water drive be modified by the introduction of an inexpensive soda solution, which under laboratory conditions greatly increases the production of oil.

Made field studies of the areas affected by the Montana and New England earthquakes of 1925. Located the point of origin of the Montana quake, and sent to press a report discussing the event fully. Issued a press bulletin giving the preliminary findings in the New England earthquake study.

Continued work in volcanology at the Hawaiian Volcano Observatory, including observations of the spectacular eruption of Mauna Loa in April.

WORK IN CHEMISTRY AND PHYSICS

Made quantitative analyses and studies of 2,621 mineral specimens and identified 3,653 specimens in response to inquiries from the public.

Tested for potash 1,800 samples from wells in Texas and New Mexico, the results confirming the conclusion that rich potash salts may be expected at relatively shallow depth.

Continued investigations of the porosity of oil sands.

Conducted temperature tests in deep wells.

Cooperated with producers in developing the field technique of the application of sodium carbonate solutions to the driving of petroleum from oil sands.

WORK IN ALASKA

Maintained eight field parties in Alaska during the field season.

Continued geologic and topographic mapping and investigation of the mineral resources of the Territory, making geologic surveys, including reconnaissance and exploratory, of 13,915 square miles, and similar topographic surveys of 9,500 square miles.

Continued the survey of Naval Petroleum Reserve No. 4, in northern Alaska, for the Navy Department.

Sent a representative to accompany the party organized by the Bureau of Aeronautics of the Navy for the airplane photographing of islands of southeastern Alaska in order to expedite topographic and geologic mapping of some 18,000 square miles of difficult territory.

Took over, by transfer from the Bureau of Mines, the supervision of the production of coal and oil on public lands in Alaska and the supervision of mine safety.

TOPOGRAPHIC WORK

Surveyed for mapping 15,535 square miles in the United States, resurveyed 1,973 square miles, made river-profile surveys of 507 miles, and ran 5,591 miles of levels.

Established 1,643 permanent bench marks, occupied 153 triangulation stations, ran 5,021 miles of transit-traverse lines, and set 1,332 permanent marks.

Mapped 838 square miles in Hawaii.

Published 61 new standard topographic maps, 15 new editions of topographic maps, 4 new or special editions of other maps, 43 river plans and profiles, advance photolithographs of 151 new topographic maps (to be engraved later), and 50 photolithographs of new topographic maps for which publication is not otherwise provided.

Maintained cooperation in topographic mapping in 24 States and Hawaii.

WORK ON WATER RESOURCES

Continued stream measurements at 1,730 gaging stations in the United States and Hawaii, 30 States cooperating, to determine the quantity of water available for irrigation, power, industrial, municipal, and domestic uses.

Conducted underground-water studies in 19 States and Hawaii.

Made 560 water analyses.

Issued monthly and annual statements on the production of electricity and consumption of fuel by public-utility power plants; also a statement on the developed water power of the United States.

Made surveys of the power or irrigation value of San Juan, Colorado, and other rivers in Colorado, Idaho, Utah, and Washington.

WORK IN CLASSIFICATION AND LEASING OF PUBLIC LANDS

Reported on 12,351 cases arising under the administration of the public-land laws.

Made classifications of public land resulting in net decreases of 313,754 acres in the total area withdrawn as possible coal land, 137,904 acres in areas withdrawn as possible oil land, and 480 acres in areas withdrawn as possible oil-shale land; also increases of 160 acres in areas withdrawn as possible phosphate land and 7,418,437 acres in areas withdrawn as possible potash land.

Reported on 5,801 applications for permits, leases, or patents under the mineral-land leasing laws.

Recommended the addition of 393,563 acres to the power-site reserves and the elimination of 35,081 acres.

Increased the area withdrawn under the Nevada ground-water reclamation act from 1,550,420 acres to 1,559,255 acres.

Recommended designations involving 705,017 acres of land available for settlement under the enlarged-homestead acts and the cancellation of designations involving 509,874 acres.

Recommended the addition of 5,466 acres to the public water reserves and the elimination of 3,591 acres.

Recommended the designation of 1,041,352 acres as stock-raising homestead land and the cancellation of designations covering 38,819 acres.

Supervised 21,273 mineral leases, licenses, and permits on public lands and naval petroleum reserves.

Supervised mineral operations on Indian lands involving 7,633 productive oil and gas wells and 86,143 acres of land containing coal, asphalt, or lead and zinc.

WORK IN PRINTING AND PUBLICATION

Edited and prepared for printing 22,342 pages of manuscript, and prepared indexes for 40 publications covering 5,686 pages.

Prepared 1,629 illustrations for reproduction in reports.

Edited for engraving 97 new topographic maps, 236 maps for reprinting, and 375 other maps.

Issued 74 books and pamphlets, including 10,133 pages; 128 new or revised maps; reprinted 188 maps—the editions aggregating 215,126 copies of books, 5,715 geologic maps and folios, and 781,947 topographic and other maps, a total of 1,002,788 copies.

Printed maps, folios, charts, etc., in a total of 3,458,459 copies, in part for 36 other Federal offices.

Distributed 227,036 books, 8,949 geologic folios, and 760,346 maps, of which 637,779 maps and folios were sold for \$47,840.86.

WORK BY THE DIRECTOR

The principal activity of the Director, outside of his routine administrative duties, was service as chairman of the advisory committee selected by the four Cabinet officers forming the Federal Oil Conservation Board, to assist them in their general study of the petroleum problem. This service and the addresses given and articles written all express in some degree the public side of the Geological Survey's work, and for that reason the list of subjects or titles follows:

Participated in discussion of technical papers at meeting of Petroleum Division, American Institute of Mining and Metallurgical Engineers, Casper, Wyo., August 28.

Address on conservation, Engineering Council of Utah, Salt Lake City, August 31.

Informal talk on coal, Lions Club, Washington, September 30.

"Heat-rich areas of United States," American Society of Mechanical Engineers, New York, November 12.

"Uncle Sam as a landlord," Maine State Society of New York, December 10.

Address on conservation, American Society of Naval Engineers, Washington, March 27.

"What makes the wheels go round?" Radio talk, Bliss Electrical School, Washington, April 8.

"Theory and practice of national self-sufficiency in raw materials," Academy of Political Science, New York, May 11.

"Our energy resources," General Federation of Women's Clubs, Atlantic City, N. J., June 2.

"A world of power," printed in *Economic Geography*, July.

"Safeguarding the nation's natural wealth," in *Current History*, August.

"Uncle Sam as a landlord," Colby Alumni, Colby College, Waterville, Me.

PUBLICATIONS

The publications of the year consisted of 74 books and pamphlets of the regular series (including 1 reprint), 128 new or revised maps, 38 reprinted maps, and numerous circulars, lists of publications, etc. The total number of pages in the book publications was 10,133. Brief notices of these publications and descriptions of the areas represented by the new maps are given below, with the special purpose of showing the scope and character of the investigative work of the Geological Survey. Owing to the variety of the subjects treated and the mass of the resulting volumes, it is impossible to comply with requests from individuals for all that the Geological Survey publishes. It is believed, however, that the descriptive notes given here will indicate the value of each volume or map to some large class of users.

In addition to the publications in the regular series, 45 brief reports were issued in mimeographed form as memoranda for the press and distributed to selected lists of journals interested in the particular subjects covered, also to individuals on application.

FORTY-SIXTH ANNUAL REPORT of the Director of the Geological Survey, for the fiscal year ended June 30, 1925; George Otis Smith, Director. ii, 91 pp., 1 pl. (map).

A detailed account of the work of the Geological Survey during the year.

PROFESSIONAL PAPER 132. Shorter contributions to general geology, 1923-24; W. C. Mendenhall, chief geologist. iv, 149 pp., 44 pls. (incl. 2 maps), 11 figs.

Contains papers on rock formations in Utah, Arizona, Wyoming, Colorado, and Pennsylvania; fossils from Montana, Texas, and Idaho; the evolution and disintegration of matter; the origin of the bog-head coals; and Aniakchak Crater, Alaska.

PROFESSIONAL PAPER 136. The flora of the Ripley formation, by E. W. Berry. i-iii, 1-94 pp., 23 pls., 6 figs.

Describes a flora of 135 species, nearly all from western Tennessee. The Ripley is the youngest Upper Cretaceous formation of the eastern Gulf region. Only brief references to its fossil plants have heretofore been published.

PROFESSIONAL PAPER 138. Mining in Colorado, a history of discovery, development, and production, by C. W. Henderson. iv, 263 pp., 1 pl. (map), 20 figs.

Contains a vast amount of information about the mining industry in Colorado, beginning with a quotation from a manuscript account of the expedition that first discovered gold in the Rocky Mountains in 1858 and carrying the history down to the end of 1923. Each of the mining counties is described in detail, and the statistics of production are given both by years and by metals. The fluctuations in production are shown graphically by means of charts. A large map of Colorado shows the relief by shading, also the location of mining districts, transmission lines, and water-power plants.

PROFESSIONAL PAPER 140-A. Geology of the Latah formation in relation to the lavas of the Columbia Plateau near Spokane, Wash., by J. T. Pardee and Kirk Bryan; Flora of the Latah formation of Spokane, Wash., and Coeur d'Alene, Idaho, by F. H. Knowlton [with a note on The fossil diatom deposit at Spokane, by Albert Mann]. 85 pp., 31 pls. (incl. 1 map), 3 figs.

Describes a series of beds near Spokane, Wash., that consist mostly of clay and shale and contain abundant fossil plants of Miocene age. These beds, which attain a maximum thickness of 1,500 feet, rest on granitic and schistose rocks and are overlain by Tertiary basalt and Pleistocene gravel. The fossils are unusually well preserved and afford evidence bearing on the geologic age of the vast lava flows that form the Columbia Plateau of Oregon, Washington, and Idaho.

PROFESSIONAL PAPER 140-B. Fossil Proboscidea and Edentata of San Pedro Valley, Ariz., by J. W. Gidley. 15 pp., 13 pls., 1 fig.

A fourth report on the collection of fossil vertebrates obtained in San Pedro Valley in 1920 and 1921, describing two mastodons and a glyptodont, all new species, and giving a somewhat fuller discussion of the geology of the fossil-bearing beds than has previously been published.

- PROFESSIONAL PAPER 140-C.** Pleistocene plants from North Carolina, by E. W. Berry. 25 pp., 14 pls. xiv-lvii, 2 figs.

Researches in Pleistocene geology in North America have been confined almost entirely to glaciology, and little study has been given to the Pleistocene deposits south of the terminal moraines. The present paper is offered in the hope that it may stimulate interest in this neglected field of research and form part of the evidence upon which future more comprehensive conclusions may be based.

- PROFESSIONAL PAPER 140-D.** Shore phases of the Green River formation in northern Sweetwater County, Wyo., by W. H. Bradley. 13 pp., 5 pls. (incl. 1 map), 2 figs.

Records the results obtained from a field and office study of shore phases of the Green River formation on the northeastern margin of the Green River Basin and presents a brief summary of the writer's conclusions regarding the origin of the Green River oil shale.

- PROFESSIONAL PAPER 140-E.** Correlation of the Eocene formations in Mississippi and Alabama, by Wythe Cooke. 5 pp.

Points out the equivalencies of formations of different facies but of the same age in the two States. In Eocene time the site of the boundary between these States lay in the transition zone between the Mississippi embayment and the Gulf of Mexico, and the deposition in the two regions was of different types.

- PROFESSIONAL PAPER 140-F.** Correlation of the basal Cretaceous beds of the Southeastern States, by Wythe Cooke. 11 pp. (incl. title-page, contents, list of illustrations, and index to volume).

Reviews the evidence for the early correlation of the Cretaceous deposits that fringe the inner margin of the Coastal Plain from Alabama to North Carolina and gives the basis for the conclusion that these deposits are Upper Cretaceous.

- PROFESSIONAL PAPER 143.** Paleontology and stratigraphy of the Castle Hayne and Trent marls in North Carolina, by L. B. Kellum. iii, 56 pp., 11 pls. 1 fig.

Report on a paleontologic investigation undertaken to clear up certain doubtful relations in the Tertiary section of North Carolina. Through the study of fossils collected at many localities a material revision of the areal geology and stratigraphic succession has been possible.

- PROFESSIONAL PAPER 145.** Geology and oil and coal resources of the Oregon Basin, Meeteetse, and Grass Creek Basin quadrangles, Wyo., by D. F. Hewett. iv, 107 pp., 32 pls. (incl. 4 maps), 10 figs.

Presents the results of an investigation of an area of about 660 square miles along the west side of the Big Horn Basin, in northwestern Wyoming, in which the principal purpose was to study the nature and structure of the rocks and any other features of the region that might yield a conclusion concerning the possible presence of petroleum. When the investigation began no drilling had been done in this region, but of the twelve well-defined anticlinal folds discovered all but one have now been explored, two have become productive oil fields, and four others have yielded considerable gas. The region also contains coal in many beds that cover wide areas, but the grade and thickness do not justify extensive exploitation.

- PROFESSIONAL PAPER 146.** Mississippian formations of San Saba County, Tex., by P. V. Roundy, G. H. Girty, and M. I. Goldman. iv, 63 pp., 33 pls., 1 fig.

Among the methods used by progressive oil producers for studying and correlating the strata penetrated by the drill the study of fossils found in drill cuttings and the comparison of such fossils with those found in known formations at their surface exposures is of great service in many fields and in exploratory work. This paper contains descriptions of the microscopic and larger fossils found in the Mississippian formations of an area in the Mid-Continent field and a discussion of the petrology of the contact between two limestones of Ordovician and Mississippian age in the same area. The paper is the first of a projected series that will give such information for different parts of the Mid-Continent field.

- BULLETIN 760.** Contributions to the geography of the United States, 1923-24; M. R. Campbell, geologist in charge. iv, 130 pp., 32 pls. (incl. 3 maps), 16 figs.

Contains papers on pedestal rocks, the physical features of central Massachusetts, and erosion by solution and fill.

- BULLETIN 766.** Spirit leveling in California, 1896-1923; C. H. Birdseye, chief topographic engineer. ii, 748 pp., 2 pls. (incl. 1 map), 50 figs.

A consolidation of chapters already issued separately, each covering one degree of latitude and longitude.

- BULLETIN 767.** Geology and coal resources of the Gallup-Zuni Basin, N. Mex., by J. D. Sears. v, 53 pp., 17 pls. (incl. 3 maps), 4 figs.

The Gallup-Zuni Basin is of both economic value and geologic interest. Its commercial importance is now centered in the Gallup coal district, in which mining has been carried on for nearly half a century and which now ranks second in production among the coal districts of New Mexico. The natural wealth of the rest of the basin has been almost untouched. This report describes the geology and mineral resources of the whole basin in a general way and the coal resources in greater detail.

BULLETIN 768. Geology and oil resources of the Puente Hills region, southern California, by W. A. English, with a section on the chemical character of the oil by P. W. Prutzman. v, 110 pp., 14 pls. (incl. 9 maps), 3 figs.

Report on an area 25 miles square lying 10 miles east of Los Angeles, of which about a third is hilly or mountainous and the remainder is highly cultivated valley land including some of the most valuable citrus land in the State. This area contains nine productive oil fields, whose combined output is normally a third of the State's total. The purpose of such reports is to lead to the more efficient development of known resources and to aid wildcatters in finding new pools with a minimum of unsuccessful drilling.

BULLETIN 771. Ore deposits of the Saddle Mountain and Banner mining districts, Ariz., by C. P. Ross. vii, 72 pp., 17 pls. (incl. 4 maps), 6 figs.

Describes an area of about 56 square miles in Pinal and Gila Counties, Ariz., which contains ores of copper, lead-silver, zinc, gold, and vanadium. Over 550,000 tons of copper ore has been shipped from this area; the output of the other ores has been small.

BULLETIN 773-D. Petroleum on Alaska Peninsula: Mineral resources of the Kamishak Bay region, by K. F. Mather; The Cold Bay-Katmai district, by W. R. Smith; The outlook for petroleum near Chignik, by G. C. Martin. 63 pp., 3 pls. (maps).

Three papers describing the geography and geology of parts of Alaska Peninsula, with special reference to the occurrence of oil.

BULLETIN 773-E. Geology and gold placers of the Chandalar district, Alaska, by J. B. Mertie, jr. 52 pp., 1 pl., 4 figs.

Describes an area of about 4,000 square miles including most of the valley of Chandalar River, north of the Arctic Circle, covered by a geologic study of about 75 days in 1923. Gold is the only metal mined in this area and is obtained from placers. The total production to the end of 1923 amounted to nearly \$300,000.

BULLETIN 773. Mineral resources of Alaska, report on progress of investigations in 1923, by A. H. Brooks and others. iii, 267, 15 pp., 6 pls. (maps), 11 figs.

Contains nine papers on mineral deposits in different parts of Alaska. This bulletin is the twentieth annual volume of the Alaskan series.

BULLETIN 774. The copper deposits near Salmon, Idaho, by C. P. Ross. iv, 44 pp., 5 pls. (incl. 1 map), 7 figs.

Describes the geology of a district that contains a number of copper deposits in which the ore is of moderate to high grade and the geologic and topographic conditions are rather favorable to mining on a small scale. The author concludes that the copper was deposited by solutions emanating from the magma of the great granite batholith of central Idaho.

BULLETIN 776. The Mesozoic stratigraphy of Alaska, by G. C. Martin. xii, 493 pp., 13 figs.

Mesozoic fossils found by Russian explorers on the Alaska Peninsula before the middle of the nineteenth century were the first features of geologic interest definitely recognized in Alaska. With the progress of areal geologic surveys during the last 25 years it has come to be recognized that the Mesozoic rocks, because of their wide distribution and the great range in the periods of their deformation and intrusion, afford the most important clues to the geologic history of the Territory. The deciphering of the Mesozoic history also has a direct bearing on the mineral resources of Alaska. This bulletin summarizes the results obtained by two score geologists in investigations covering more than 20 years.

BULLETIN 777. Pre-Cambrian rocks of Gunnison River, Colo., by J. F. Hunter. vi, 94 pp., 15 pls. (incl. 1 map), 5 figs.

Gives a detailed description of the pre-Cambrian complex of metamorphic and igneous rocks that wall the canyons of Gunnison River and its larger tributaries.

BULLETIN 778. Chemistry of deposition of native copper from ascending solutions, by R. C. Wells. ii, 71 pp., 2 figs.

Presents the results of an investigation made to determine the chemical changes involved in the deposition of native copper in the Lake Superior district. The investigation was made in connection with a geologic study of the ore deposits and covered a problem concerning which little or no information was available. It included 165 chemical experiments, which are set forth in detail in this report. Much of the information is suggestive for other conditions and districts.

BULLETIN 779. Guides to ore in the Leadville district, Colo., by G. F. Loughlin, iii, 37 pp., 7 pls. (incl. 1 map), 4 figs.

Presents in brief form the data of most value to mine operators and their engineers from the exhaustive report on the Leadville mining district just sent to press, in order to focus attention more sharply on the problems of ore hunting. The general geology is summarized, and the occurrence and significance of the guides now available in the search for ore are set forth. Some "guides" that may be more aptly termed "detour signs" are also described.

- BULLETIN 780-B.** Geology of a part of western Texas and southeastern New Mexico, with special reference to salt and potash, by H. W. Hoots. 99 pp. 15 pls. (incl. 2 maps), 1 fig.

A report on the progress made in the search for potash in the vast salt deposits of the Southwest, which extend over a region several hundred miles in length and at least 200 miles in width. The information already obtained indicates the existence in this region of potash reserves of probable commercial value within practicable reach from the surface. The investigation so far has been largely haphazard and carried on principally by examination of samples from wells drilled for oil. The surprising results obtained from such work justify systematic field investigations that will test the region thoroughly.

- BULLETIN 780-C.** Platinum near Centennial, Wyo., by F. L. Hess. 11 pp., 1 fig.

Commercially valuable deposits of platinum are rare, and this paper sets forth the results of a brief investigation made because of press reports of platinum discoveries near Centennial. The author concludes that although platinum metals are undoubtedly present on Centennial Ridge they occur in very small quantities.

- BULLETIN 780-D.** Antimony and quicksilver deposits in the Yellow Pine district, Idaho, by F. C. Schrader and C. P. Ross. 39 pp. (incl. title-page, contents, list of illustrations, and index to volume), 2 pls. (incl. 1 map), 4 figs.

The Yellow Pine district contains considerable deposits of antimony and quicksilver, but owing to the inaccessibility of the region and the lack of adequate development the output has been small. The showings so far made, however, are sufficiently favorable to justify further development, and this paper gives a summary of the available information on the district.

- BULLETIN 781-A.** Paleozoic formations penetrated by wells in Tishomingo County, northeastern Mississippi, by M. N. Bramlette; with Notes on Paleozoic rocks encountered in a well near Florence, Ala., by H. D. Miser. 14 pp., 1 pl.

Reports on a detailed study of drill cuttings from three wells drilled for oil, giving information that is of great value to the oil prospector.

- BULLETIN 781-B.** Geology of the Baxter Basin gas field, Sweetwater County, Wyo., by J. D. Sears. 22 pp. (incl. title-page, contents, list of illustrations, and index to volume), 5 pls. (incl. 1 map), 1 fig.

The discovery of gas in commercial quantity in Baxter Basin, the structurally highest part of the Rock Springs anticline, brought a demand for further information concerning the structure and extent of the field, the relation of the gas to the structure, and the possibility of the occurrence of oil. This report presents the results of a detailed study undertaken to obtain information on these subjects.

- BULLETIN 781.** Contributions to economic geology (short papers and preliminary reports), 1925. Part II. Mineral fuels; W. T. Thom, Jr., geologist in charge. iii, 29 pp., 6 pls. (incl. 1 map), 1 fig.

Contains papers on Paleozoic formations penetrated by wells in Mississippi and Alabama and the Baxter Basin gas field, Wyoming.

- BULLETIN 783-A.** Mineral industry of Alaska in 1924 and Administrative report, by P. S. Smith; Selected list of Survey publications on Alaska. 58 pp.

The first chapter of the annual volume on the Geological Survey's work in Alaska. The total value of the mineral output to the end of 1924 is given as more than \$535,000,000, of which more than \$500,000,000 is in gold and copper. Alaska's minerals form less than half the total wealth of the Territory, which is shown to be really a treasure box and not the liability which some people suppose it to be.

- BULLETIN 785-A.** Recent developments in the Aspen district, Colorado, by Adolph Knopf. 30 pp., 1 pl. (map), 6 figs.

The Aspen district was mapped and studied with great detail 30 years ago. Mining in the area then surveyed has come to a standstill, but recent exploratory work a little farther south has led to a demand for a southward extension of the early survey. This report sets forth the results obtained in an investigation designed to meet that demand. It contains a geologic map of the district, including the southern area, in which the recent work has been done.

- BULLETIN 785-B.** Potash investigations in 1924, by W. B. Lang. 17 pp., 1 pl. (map), 2 figs.

Progress report on the investigations made by the Geological Survey in the Southwest, mainly in Texas, in search of potash in the Permian salt beds. Records some notable contributions to knowledge that serve to strengthen the conviction that the presence of commercial beds of potash in this region will eventually be proved.

WATER-SUPPLY PAPER 490. The Papago country, Arizona, a geographic, geologic, and hydrologic reconnaissance, with a guide to desert watering places, by Kirk Bryan. xviii, 436 pp., 27 pls., 41 figs.

The Papago country, which lies south of Gila River, between Tucson and Yuma, until recently has been rarely visited by white men, for it has seemed waterless and formidable—a desert that has perhaps taken a larger toll of human life than any other arid section of the United States—yet for unknown generations it has provided a home and livelihood for a simple-hearted, peace-loving tribe of Indians. In recent years the Papago country has become much more accessible through the use of automobiles, the establishment of a mining camp, and the building of a railroad. This report contains a vast amount of information, in large part original, obtained by the author in the field. It includes a brief but vivid historical sketch, by F. L. Ransome, which goes back to the era of Spanish exploration. The report is as nearly a complete physical geography as it is possible to write. The main emphasis, however, is placed on the water resources of this region, which are described in much detail. A guide to watering places includes road logs giving measured distances, supplemented by descriptive notes.

WATER-SUPPLY PAPER 520. Contributions to the hydrology of the United States, 1923-24; N. C. Grover, chief hydraulic engineer. iv, 129 pp., 12 pls. (incl. 2 maps), 11 figs.

Contains papers on run-off and floods in the Rocky Mountain region; water supplies for Enid, Okla.; power resources of Snake River, Oreg.-Idaho; base exchange in ground water; artesian-water supply of the Dakota sandstone in North Dakota; and temperature of water available for industrial use.

WATER-SUPPLY PAPER 522. Surface water supply of the United States, 1921, Part II, South Atlantic slope and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; A. H. Horton, G. C. Stevens, and W. E. Hall, district engineers. iv, 72 pp., 2 pls.

WATER-SUPPLY PAPER 526. Surface water supply of the United States, 1921, Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb, Robert Follansbee, E. D. Burchard, R. C. Rice, and E. L. Williams, district engineers. vii, 331 pp., 2 pls.

WATER-SUPPLY PAPER 529. Surface water supply of the United States, 1921, Part IX, Colorado River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, A. B. Purton, and R. C. Rice, district engineers. v, 181 pp., 2 pls.

WATER-SUPPLY PAPER 533. Surface water supply of the United States, 1921, Part XII, North Pacific slope drainage basins: B, Snake River basin; N. C. Grover, chief hydraulic engineer; G. C. Baldwin, G. L. Parker, C. G. Paulsen, A. B. Purton, and F. F. Henshaw, district engineers. vi, 292 pp., 2 pls.

WATER-SUPPLY PAPER 534. Surface water supply of the United States, 1921, Part XII, North Pacific slope drainage basins: C, Lower Columbia River basin and Pacific slope drainage basins in Oregon; N. C. Grover, chief hydraulic engineer; F. F. Henshaw and G. L. Parker, district engineers. v, 171 pp., 2 pls.

Five of the annual reports on stream gaging, covering the year ending Sept. 30, 1921.

WATER-SUPPLY PAPER 542. Surface water supply of the United States, 1922, Part II, South Atlantic slope and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; A. H. Horton, W. R. King, and W. E. Hall, district engineers. iv, 74 pp., 2 pls.

WATER-SUPPLY PAPER 543. Surface water supply of the United States, 1922, Part III, Ohio River basin; N. C. Grover, chief hydraulic engineer; A. H. Horton, Lasley Lee, H. E. Grosbach, W. R. King, and W. E. Hall, district engineers. vi, 262 pp., 2 pls.

WATER-SUPPLY PAPER 544. Surface water supply of the United States, 1922, Part IV, St. Lawrence River basin; N. C. Grover, chief hydraulic engineer; S. B. Soulé, A. H. Horton, Lasley Lee, C. C. Covert, A. W. Harrington, and C. H. Pierce, district engineers. iv, 140 pp., 2 pls.

WATER-SUPPLY PAPER 545. Surface water supply of the United States, 1922, Part V, Hudson Bay and upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. A. Lamb, S. B. Soulé, E. D. Burchard, J. B. Spiegel, H. E. Grosbach, and E. L. Williams, district engineers. v, 197 pp., 2 pls.

WATER-SUPPLY PAPER 546. Surface water supply of the United States, 1922, Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb, Robert Follansbee, J. B. Spiegel, and E. L. Williams, district engineers. vii, 349 pp., 2 pls.

WATER-SUPPLY PAPER 547. Surface water supply of the United States, 1922, Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; E. L. Williams and Robert Follansbee, district engineers. iv, 106 pp., 2 pls.

WATER-SUPPLY PAPER 548. Surface water supply of the United States, 1922, Part VIII, Western Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; C. E. Ellsworth, district engineer. iv, 124 pp., 2 pls.

WATER-SUPPLY PAPER 552. Surface water supply of the United States, 1922, Part XII, North Pacific slope drainage basins: A, Pacific basins in Washington and upper Columbia River basin; N. C. Grover, chief hydraulic engineer; G. L. Parker and W. A. Lamb, district engineers. v, 203 pp., 2 pls.

Eight of the annual reports on stream gaging for the year ending September 30, 1922.

WATER-SUPPLY PAPER 556. Water power and flood control of Colorado River below Green River, Utah, by E. C. LaRue, with a foreword by Hubert Work, Secretary of the Interior. x, 176 pp., 79 pls. (incl. 42 maps), 1 fig.

The drainage basin of Colorado River covers 244,000 square miles and lies in seven States and Mexico, and the problems of developing the resources of the river are of interstate and international interest. No other river on this continent affords such enormous opportunities for the use of its water for both irrigation and water power. The canyon section of the river contains the second largest concentration of water-power sites in the United States. Although dams in the canyon would create stretches of slack water, nowhere would any appreciable part of the beautiful canyon walls be submerged. Irrigation is already practiced to a considerable extent in the upper part of the basin, in Wyoming, Colorado, and Utah, and below the canyon section there are great areas of fertile land that can be made productive if irrigated. The most urgent need of the basin is flood protection for cities, towns, and large irrigated areas on the lower river. The complexity of the problems involved in the development of the vast resources of this basin requires a knowledge of the essential engineering facts to serve as a guide. Such a knowledge this paper is intended to afford. Colorado River has been under observation, survey, and study since the end of the Civil War, and the Geological Survey's investigations have covered many years. The author prepared the first comprehensive report on the river, issued in 1916, and has since worked almost continuously on studies within the basin, having made boat trips on the river and its tributaries aggregating nearly 2,000 miles and taken over a thousand photographs. The paper contains also a brief geologic report on the inner gorge of the Grand Canyon, by R. C. Moore.

WATER-SUPPLY PAPER 558. Preliminary index to river surveys made by the United States Geological Survey and other agencies, by B. E. Jones and R. O. Holland. iv, 108 pp., 2 pls. (maps).

A compilation prepared primarily for the use of Government bureaus to afford information concerning the rivers on which surveys have been made by Federal, State, semipublic, and private agencies and concerning the character of the available maps based on such surveys. The list is arranged by States and drainage basins.

WATER-SUPPLY PAPER 560-D. Preliminary report on the geology and water resources of the Mud Lake basin, Idaho, by H. T. Stearns and L. L. Bryan. 55 pp. (incl. title-page, contents, list of illustrations, and index to volume), 2 pls. (maps), 2 figs.

Report on an investigation made to afford a basis for intelligent decision regarding numerous land and water fillings in a region whose water supply had never been adequately determined and had within the last 25 years notably increased.

WATER-SUPPLY PAPER 560. Contributions to the hydrology of the United States, 1925; N. C. Grover, chief hydraulic engineer. iii, 134 pp., 2 pls.

Contains papers on water power and irrigation in the Madison River basin, Mont.; the chemical character of ground waters of the northern Great Plains; and the geology and water resources of the Mud Lake basin, Idaho; also an index of analyses of natural waters in the United States.

WATER-SUPPLY PAPER 561. Surface water supply of the United States, 1923, pt. 1, North Atlantic slope drainage basins; N. C. Grover, chief hydraulic engineer; C. H. Pierce, A. W. Harrington, O. W. Hartwell, and A. H. Horton, district engineers. vi, 294 pp., 3 pls.

WATER-SUPPLY PAPER 562. Surface water supply of the United States, 1923, Part II, South Atlantic slope and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; A. H. Horton, W. E. Hall, and W. R. King, district engineers. iv, 86 pp., 3 pls.

WATER-SUPPLY PAPER 563. Surface water supply of the United States, 1923, Part III, Ohio River basin; N. C. Grover, chief hydraulic engineer; A. H. Horton, Lasley Lee, H. E. Grosbach, W. R. King, and W. E. Hall, district engineers. vi, 258 pp., 3 pls.

WATER-SUPPLY PAPER 567. Surface water supply of the United States, 1923, Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; E. L. Williams, H. C. Beckman, Robert Follansbee, and H. B. Kinnison, district engineers. iv, 122 pp., 3 pls.

WATER-SUPPLY PAPER 572. Surface water supply of the United States, 1923, Part XII, North Pacific slope drainage basins: A, Pacific basins in Washington and upper Columbia River basin; N. C. Grover, chief hydraulic engineer; G. L. Parker and W. A. Lamb, district engineers. v, 193, 11 pp., 3 pls.

Five of the annual reports on stream gaging for the year ending September 30, 1923.

MINERAL RESOURCES OF THE UNITED STATES, 1922. Parts I and II.

MINERAL RESOURCES OF THE UNITED STATES, 1923. 4 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1924. 7 advance chapters.

GEOLOGIC FOLIO 220. Gillespie-Mount Olive, Ill., by Wallace Lee. 14 folio pages of text, 4 maps, 16 figs.

Describes the geology of an area of 463 square miles in west-central Illinois, a part of the Till Plains section of the Central Lowland physiographic province. The ice sheets that covered this area filled many depressions with drift and rounded the irregularities of the surface, leaving a fairly smooth plain, which has since been moderately dissected by stream erosion. The area is well but not thickly settled and is crossed by eight railroads. The bedrocks are of sedimentary origin and consist of nearly horizontal beds of shale, sandstone, limestone, and coal, which are almost entirely concealed by unconsolidated surficial deposits. The chief mineral resource of this area is coal, of which about 8,000,000 tons was produced in 1924. The area has also yielded small quantities of oil and gas.

TOPOGRAPHIC AND OTHER MAPS as follows. The maps marked with an asterisk (*) were published also with green overprint showing woodland.

Alabama

***GRAVELLY SPRINGS:** Latitude, 34° 45' to 35°; longitude, 87° 45' to 88°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Lauderdale and Colbert Counties, in the Highland Rim Plateau, whose upland surface stands about 600 to 900 feet above sea level. Tennessee River flows across the area in a shallow valley with a flood plain a mile wide that lies 400 feet above the sea. The southeastern half of the area is gently rolling, with broad, shallow valleys and with more or less nearly level land on the divides. There are numerous sink holes and larger depressions without surface drainage, and a number of them contain small ponds. The northwestern part is more rugged, having been rather completely dissected by streams that flow in valleys 200 to 400 feet deep, with narrow flood plains.

Alaska

ALASKA (map showing distribution of mineral deposits). Scale, 1 inch=approximately 80 miles. Size, 19 by 26 inches.

Revised edition of a map of Alaska showing, by colored symbols, the known or suspected distribution of coal deposits and the location of metalliferous mines, marble quarries, petroleum seepages, etc.

Arizona

STATE OF ARIZONA (relief map). Scale, 1 inch=approximately 8 miles; no contour lines. Size, 56 by 44 inches.

Shaded relief map in which the physical features are brought out by an overprint in shades of brown. The water features are shown in blue. The map displays clearly the difference in altitude and relief between the northeastern half of the State, which is part of the Colorado Plateaus, and the southwestern half, which is part of the Basin and Range province. The Grand Canyon and the canyons of several smaller streams are conspicuous features in the northwestern part, and the broad, nearly level plains that occupy the valleys between the numerous small mountain ranges are equally conspicuous in the southwestern part. San Francisco Mountain, somewhat north of the center of the State, although the highest point in Arizona, rises so little above the Coconino Plateau, on which it stands, that it is not conspicuous on the shaded map. The Roosevelt Reservoir, near Phoenix, a wholly artificial lake, stands out strikingly in a region notable for its general aridity.

California

- * **ALHAMBRA**: Latitude 34° to $34^{\circ} 6'$; longitude, $118^{\circ} 6'$ to $118^{\circ} 12'$. Scale, 1 inch=2,000 feet; contour intervals, 5 and 25 feet.

Map of part of Los Angeles County, just east of the city of Los Angeles. A range of irregular hills, separated by transverse gulches 200 to 400 feet deep, extends southeastward across the area. The altitude of the summits ranges from 550 to 882 feet. The relief of the lower slopes of the hills is shown by 5-foot contours, but above 500 feet the contour interval is 25 feet, and the map thus gives the upper slopes of the hills a deceptive appearance of flatness, as compared with the lower slopes. The northeastern part of the area has a rolling surface, nearly all of which lies less than 500 feet above sea level and has a general easterly slope. The southwestern part has a similar rolling surface, mainly less than 300 feet above the sea, which descends southward, toward the coast. There are no permanent streams in the area, and the only bodies of water are a few small reservoirs.

- * **ARTESIA**: Latitude, $33^{\circ} 48'$ to $33^{\circ} 54'$; longitude, 118° to $118^{\circ} 6'$. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of a small part of Los Angeles County, in the coastal plain of southern California. Only the northwest half of the Artesia quadrangle is shown. Most of the area is a plain whose surface descends gently from 88 to 17 feet above sea level and is trenched slightly by the channels of San Gabriel River and other small wet-weather streams. In the northeast corner low outliers of the Puente Hills reach an altitude of 190 feet.

- * **BELL**: Latitude, $33^{\circ} 54'$ to 34° ; longitude, $118^{\circ} 6'$ to $118^{\circ} 12'$. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of part of Los Angeles County, in the coastal plain of southern California, whose gently rolling surface ranges in altitude from 75 to 200 feet. There are no permanent streams, but the area is crossed by Los Angeles and San Gabriel Rivers and Rio Hondo, all intermittent streams, parts of whose courses have been straightened and confined between levees.

- * **CARUTHERS**: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, $119^{\circ} 45'$ to $119^{\circ} 52' 30''$. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 5 feet.

Map of part of Fresno County, in San Joaquin Valley, between San Joaquin and Kings Rivers. The area is a slightly irregular plain that descends from 280 to 225 feet above sea level. The most striking features of the topography are numerous small, irregular southeastward-trending depressions whose bottoms are 5 to 15 feet below the general level and whose origin has not been determined. A line of deeper depressions that appears to mark a former overflow of Kings River trends southwestward across the southern part of the area. There are no permanent streams, but the area is crossed by several irrigation ditches.

- * **CLEARWATER**: Latitude, $33^{\circ} 48'$ to $33^{\circ} 54'$; longitude, $118^{\circ} 6'$ to $118^{\circ} 12'$. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of part of Los Angeles County, in the coastal plain of southern California, whose gently rolling surface descends from 80 to 15 feet above sea level. The area is crossed by a range of low hills which culminate in Signal Hill, 360 feet above sea level, at the southern margin. The area includes a portion of the famous Signal Hill oil field.

- * **HELM**: Latitude, $36^{\circ} 30'$ to $36^{\circ} 37' 30''$; longitude, 120° to $120^{\circ} 7' 30''$. Scale, 2 inches=1 mile; contour interval, 5 feet.

Map of part of Fresno County, in San Joaquin Valley, between San Joaquin and Kings Rivers. The area is a nearly flat plain lying 180 to 210 feet above sea level and marked by small, irregular mounds and hollows 5 to 10 feet above or below the general level. In the eastern part are a few low alluvial ridges formed by distributaries of Kings River, the former channel of which, occupied when the river flowed to the San Joaquin, crosses the area in a northwesterly direction.

- * **HOLLYWOOD**: Latitude, 34° to $34^{\circ} 6'$; longitude, $118^{\circ} 18'$ to $118^{\circ} 24'$. Scale, 1 inch=2,000 feet; contour intervals, 5 and 25 feet.

Map of an area in Los Angeles County, including the west-central part of the city of Los Angeles. The northwest corner lies on the southern slope of the Santa Monica Mountains, and a little of the southern part lies in the Baldwin Hills. The highest point is on a spur of the Santa Monica Mountains at 1,025 feet above sea level. The southern and western parts of the area are occupied chiefly by a rolling plain, whose surface slopes gently from the base of the surrounding hills to less than 100 feet above sea level along the streams. Much of the more densely built-up portion of Los Angeles lies on a terrace at a little more than 200 feet above sea level. The north-central part of the area is occupied by the famous La Brea oil field, in which are the asphalt pits from which so many interesting remains of extinct animals have been exhumed. The relief of the parts of the area that lie more than 500 feet above sea level is shown by 25-foot contour lines, which give a deceptive appearance of flatness to the higher slopes.

LONG BEACH: Latitude, 33° 44' to 33° 48'; longitude, 118° 5' to 118° 12'. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of part of Los Angeles County, along the coast of San Pedro Bay at the east end of the San Pedro Hills. The greater part of the area is occupied by irregular hills, culminating in Signal Hill, 360 feet above sea level. The eastern part, which lies in the coastal plain of southern California, is less than 20 feet above sea level and is largely occupied by marshes and lagoons along the course of San Gabriel River. As shown by underwater contours, the flat surface of the plain extends southward beneath the Pacific. A part of the famous oil field of Signal Hill lies at the northern margin.

LAISIN: Latitude, 36° 30' to 36° 37' 30''; longitude, 119° 52' 30'' to 120°. Scale, 1 inch=½ mile; contour interval, 5 feet.

Map of an area in Fresno County, in San Joaquin Valley. The surface descends very gently from 245 to 195 feet above sea level and is almost featureless, except for many small, irregular knolls and hollows, whose origin is problematical.

AN JOAQUIN: Latitude, 36° 30' to 36° 37' 30''; longitude, 120° 7' 30'' to 120° 15'. Scale, 1 inch=½ mile; contour interval, 5 feet.

Map of part of Fresno County, in San Joaquin Valley. The area is a flat, almost featureless valley floor that lies 165 to 185 feet above sea level throughout most of the area but rises gently to 245 feet in the southwest corner. A small stream called Fresno Slough flows across the area, and several irrigation canals lead from it to the adjacent territory.

SAWTELLE: Latitude, 34° to 34° 6'; longitude, 118° 24' to 118° 30'. Scale, 1 inch=2,000 feet; contour intervals, 5 and 25 feet.

Map of a small area in Los Angeles County, extending from the south slope of the Santa Monica Mountains to Venice and Santa Monica Bay. The lowlands in the southern part of the area are represented with a contour interval of only 5 feet; the northern part, where the surface is more rugged, is represented with a contour interval of 25 feet. This change of interval gives to the lower country the appearance of greater relief and to the mountain area the appearance of less relief than it really has. The altitude ranges from sea level on Santa Monica Bay to 1,600 feet in the mountains. The map shows excellently the flat-bottomed arroyos that are so characteristic of erosion in the soft sediments composing the mountain slopes.

WHITTIER: Latitude, 33° 54' to 34°; longitude, 118° to 118° 6'. Scale, 1 inch=2,000 feet; contour interval, 5 and 25 feet.

Map of part of Los Angeles County at the base of the Puente Hills, which reach an altitude of 1,387 feet. The change of contour interval at the 500-foot level causes the higher slopes of these hills to appear less steep than they really are. A lower range of hills crosses the southern part of the area. The rest of the area lies in the coastal plain of southern California, at 80 to 150 feet above sea level. Its northwest corner is crossed by the channel of San Gabriel River, an intermittent stream. The map shows a large group of oil wells in the Puente Hills and another in the western part of the area.

ELMINGTON: Latitude, 33° 42' to 33° 48'; longitude, 118° 12' to 118° 18'. Scale, 1 inch=2,000 feet; contour interval, 5 feet.

Map of an area in Los Angeles County, situated on the coast and chiefly in the coastal plain of southern California. The western margin lies on the eastern slope of the San Pedro Hills, which rise 300 feet above sea level at one point in the reservation of Fort McArthur, back of Point Fermin. In the northern part of the area the surface slopes gently southeastward from 45 feet above sea level to the shore. Along the coast a belt 1 to 2 miles wide lies but a few feet above sea level and is so nearly flat that part of it is marshy. The artificial harbor of Los Angeles, which lies within this area, adjoining San Pedro, has been constructed largely by excavating and dredging in this low belt. Under-water contour lines show that the adjacent sea bottom in San Pedro Bay and the Pacific Ocean is very flat and slopes gently southeastward in continuation of the slope of the coastal plain on the land.

California-Oregon

KLAMATH RIVER. Plan and profile of Klamath River, Calif.-Oreg. (below Keno). Scale, 1 inch=4,000 feet; contour intervals, on land 25 feet, on river surface 5 feet; vertical scale of profiles, 1 inch=40 feet. Size, 19 by 21 inches. 16 sheets (9 plans, 7 profiles).

Sheets A to I show the course of Klamath River and its principal tributaries—Scott, Trinity, and Salmon Rivers—and part of South Fork of Smith River, the relief of the immediately adjacent slopes, and the position of bridges, ferries, dam sites, roads, and settlements. Sheets J to P show the profiles of the streams throughout the stretches mapped. Comparison of the profiles with the plans shows the relation of the stream grade to the width of the valley bottom, the extent of alluviation, and the character of the bordering slopes.

District of Columbia

[See Maryland-Virginia-District of Columbia]

Hawaii

- * **KAHULUI:** Latitude, 20° 45' to 21°; longitude, 156° 15' to 156° 30'. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of the north-central part of Maui, mainly on the northwest slope of the great volcanic cone of the island. The western part of the area includes the neck that joins the two parts of the island and a portion of the south shore. The southeast corner stands 7,700 feet above sea level, and the surface slopes northward and westward to the shore. The ravines that furrow the northern slope are notably deeper and sharper than those on the western slope because of the heavier rainfall on the north side.

- * **LAHAINA:** Latitude, 20° 47' 30'' to 21° 2' 30''; longitude, 156° 30' to 156° 42' 30''. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of part of the Island of Maui, including all the peninsula west of the isthmus that joins it to the main island. The whole land area consists of the summit and slopes of the volcano Puukukui, whose highest point is 5,788 feet above sea level. Several other prominent peaks stand at altitudes of 4,000 to 5,000 feet on the slopes of the central mass, which is deeply furrowed by ravines radiating in all directions to the coast. The rimless Eke Crater, on the northern slope of Puukukui, 2 miles from the summit, has a level marshy floor 4,480 feet above sea level.

Idaho

- SALMON RIVER.** Plan and profile of Salmon River, Salmon to Stanley. Scale, 1 inch= $\frac{1}{2}$ mile; contour intervals, on land 25 feet, on river surface 5 feet; vertical scale of profiles, 1 inch=40 feet. Size, 19 by 20 inches. 7 sheets (4 plans, 3 profiles).

Sheets A to D show the course of the river, the location of dam sites and bridges, and the highways adjacent to the stream. The contour lines bring out the contrast between the wide, flat-bottomed valley with low bordering slopes where the river is flowing across a plain, and the narrow, steep-sided valley where the river is flowing through the foothills. Sheets E to G show the profile of the river throughout the stretch mapped.

Illinois

[See also Kentucky-Illinois and Missouri-Illinois]

- * **CARLINVILLE:** Latitude, 39° 15' to 39° 30'; longitude, 89° 45' to 90°. Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of an area in Macoupin County, in the Till Plains. The general surface is a rolling prairie that descends gently from 690 to 620 feet above sea level. A small eminence called Coops Mound, 5 miles northeast of Carlinville, rises 60 feet above the prairie. Several creeks flow southwestward in small valleys 40 to 60 feet deep with narrow flood plains in which lie a few small abandoned meanders.

- * **ELGIN:** Latitude, 42° to 42° 15'; longitude, 88° 15' to 88° 30'. Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of an area about 80 miles west of Chicago that lies mainly in McHenry and Kane Counties but includes a small part of Cook County. The general aspect of the area is that of a plain at an altitude of about 900 feet, above which stand ridges and irregular masses of morainic drift. The principal ridge rises to 1,080 feet. Fox River, which flows south along the east margin of the area, has cut a trench in the plain nearly 200 feet deep. This trench contains several abandoned meanders, the most perfect of which is a complete loop just below West Dundee. Meander scars back of Carpentersville and near Meadowdale School show that the river formerly flowed in a very much more crooked course.

- * **HARRISBURG:** Latitude, 37° 30' to 37° 45'; longitude, 88° 30' to 88° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Saline, Pope, Williamson, and Johnson Counties, partly in the Till Plains and partly in the upland of southern Illinois. The northern part is occupied mainly by groups of low irregular hills that rise 500 to 600 feet above sea level, with slopes much furrowed by small ravines. The groups of hills are separated and more or less surrounded by flat, prairie-like valleys that lie 300 to 400 feet above sea level. South Fork of Saline River and several smaller streams flow through the valleys in courses so devious that at many places they have been artificially straightened to improve the drainage. The southern part is a closely dissected hilly tract in which the hilltops stand 700 to 860 feet above sea level and the small narrow valleys have been cut to a depth of 100 feet or more.

HAVANA: Latitude, 40° 15' to 40° 30'; longitude, 90° to 90° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Fulton and Mason Counties, in the Till Plains, whose general surface lies 600 to 680 feet above sea level. Considerable level upland still remains on the main divides, but near the larger valleys the margins of the upland are much dissected by small ravines 40 to 100 feet deep. Illinois River crosses the area in a valley 3 miles wide with a floor so flat that it is subject to inundation, and the streams crossing it are largely confined between levees. The part of the area south-east of Illinois River is a broad terrace 40 to 60 feet above the stream, on which stand numerous irregular knolls 20 to 60 feet high that have the appearance of old sand dunes.

MARION: Latitude, 37° 30' to 37° 45'; longitude, 88° 45' to 89°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Williamson and Johnson Counties, partly in the Till Plains and partly in the upland of southern Illinois. The greater part lies in the upland, a region of irregular hills and sinuous ridges, whose summits stand 550 to 800 feet above sea level. The hills are separated by valleys 50 to 150 feet in depth. Some of these valleys are narrow and V-shaped; others have flood plains as much as a mile in width, on which the streams meander in small loops. The northwest corner is a till plain whose rolling surface stands 400 to 500 feet above sea level.

*** YORKVILLE:** Latitude, 41° 30' to 41° 45'; longitude, 88° 15' to 88° 30'. Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of an area in Kendall, Will, and Du Page Counties, in the Till Plains close to their northeastern margin. The surface is a rolling plain 600 to 680 feet above sea level, across which Fox River flows in a sinuous trench 50 to 100 feet deep. A belt of morainal hills, whose summits stand 750 to 800 feet above sea level, extends across the west-central part of the area, and a similar but lower belt extends along the east side. Part of the city of Aurora lies just within the northern part of the area.

Kentucky

*** SPRING LICK:** Latitude, 37° 15' to 37° 30'; longitude, 86° 30' to 86° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Butler, Ohio, and Grayson Counties, in the Highland Rim Plateau, whose general surface stands 600 to 700 feet above sea level and descends gently westward. The upland is rather completely dissected by valleys 250 to 300 feet deep, most of which are V-shaped or have narrow flood plains, but the valleys of Green River and Caney Creek have flood plains nearly a mile wide, which lie 400 to 450 feet above sea level.

Kentucky-Illinois

DAVE IN ROCK: Latitude, 37° 15' to 37° 30'; longitude, 88° to 88° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Crittenden, Livingston, and Caldwell Counties, Ky., and Hardin County, Ill., in the low hilly upland that borders the Highland Rim Plateau on the northwest. The upland surface, which is so much dissected that there is almost no level land on the divides, stands 600 to 700 feet above sea level, and a few summits rise to nearly 800 feet. The valleys are cut 100 to 300 feet below the upland, and Ohio River flows across the area in a valley 1 to 2 miles wide whose nearly flat floor is 340 feet above sea level. Small lime sinks, some of which contain ponds, are abundant in part of the area, especially on the Illinois side of the river. Earlier editions of this map showed only the part in Illinois. Published also with gray overprint showing the relief by shading.

Maine

*** ATTEAN:** Latitude, 45° 30' to 45° 45'; longitude, 70° 15' to 70° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Somerset County, in northwestern Maine. The Canadian boundary crosses the northwest corner of the area, and the part that lies in Canada is not shown. The surface is a mountainous plateau that ranges in altitude from 1,157 to 3,168 feet. A number of summits stand 2,200 to 2,800 feet above sea level. The area has been heavily glaciated and is characterized by drift-choked valleys, most of which are partly occupied by ponds and swamps, and by the strikingly unsystematic and unadjusted drainage pattern, which is well shown by the erratic course of Moose River. The Canadian Pacific Railway and the main highway from central Maine to Quebec cross the area, which is densely forest-covered and is almost uninhabited except for a few small villages along or near the railroad and scattered houses along the highway.

*** BURNHAM:** Latitude, 44° 30' to 44° 45' longitude, 69° 15' to 69° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Waldo, Kennebec, and Somerset Counties, whose rather irregular surface is diversified by numerous small hills and groups of hills that stand 50 to 300 feet above the general surface. The northwest corner of the area is occupied by a broadly rolling upland whose highest point is 440 feet above sea level, and the southeastern third is a rough, hilly tract whose culminating points reach 600 to 900 feet. Between the two upland areas lies a lowland belt 6 miles wide, which trends southwestward across the middle of the area. Its general surface, largely covered by bogs and swampy meadows, lies about 175 feet above sea level, but numerous small hills and ridges rise 20 to 150 feet higher.

Maryland

LAUREL: Latitude, 39° to $39^{\circ} 15'$; longitude, $76^{\circ} 45'$ to 77° . Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 20 feet.

Map of an area in Howard, Prince Georges, Montgomery, Anne Arundel, and Baltimore Counties, just northeast of the District of Columbia. The northwest half is in the Piedmont Upland, whose general surface declines gently southeastward from 600 to about 400 feet above sea level. Patapsco, Patuxent, and Little Patuxent Rivers and other southeastward-flowing streams have cut valleys 100 to 200 feet deep in the upland, and the tributary streams have also considerably dissected it, though some fairly level tracts remain on the divides. The southeastern part of the area is in the Atlantic Coastal Plain, whose surface stands 260 feet or more above sea level along its northwest margin and declines gently southeastward. The main streams flow across the plain in broad valleys about 100 feet deep with flood plains half a mile or more in width. The upland and the plain are separated by the Fall Belt escarpment, in which the surface descends 200 to 400 feet. Here the main rivers have cut gorges whose depth is about the same as the height of the scarp, and numerous small streams that rise near the top of the scarp and flow down the slope have furrowed it rather deeply. Along the base of the scarp is the Fall Line, where the streams pass from the crystalline rocks of the Piedmont to the soft sediments of the Coastal Plain. In the Laurel area the Fall Line is not marked by any considerable falls or rapids, but there is a rather striking change from narrow V-shaped gorges to wide, shallow, flat-bottomed valleys.

Maryland-Virginia

* **INDIAN HEAD:** Latitude, $38^{\circ} 30'$ to $38^{\circ} 45'$; longitude, 77° to $77^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Charles and Prince Georges Counties, Md., and Fairfax and Prince William Counties, Va. The area is in the Coastal Plain, whose surface descends gently from 300 to 100 feet above sea level. The estuary of Potomac River, 1 to 3 miles in width, crosses the area in a sinuous course, and much of the surface bordering the estuary and the tidal bays and creeks tributary to it lies only 20 to 40 feet above sea level. At some places, however, the shore is bordered by bluffs, which at Gunston Hall, Fort Humphreys, and Mount Vernon are 100 feet high and at Fort Washington 160 feet high. At other places the line of bluffs stands 2 miles or more back from the shore and has the characteristic concave outlines of meander scars, showing that the river at one time flowed in a more meandering course and at a higher altitude. The lower ground along the river is largely the flood plain of that earlier time. Mount Vernon stands on a cut-off meander spur, separated from the main upland on the Virginia side by a broad oxbow valley, whose floor now lies at an altitude of about 40 feet. The form of the bed of the Potomac estuary and its tributaries is shown by under-water contour lines. A map of this quadrangle, issued in 1913, showed only the part in Maryland. The culture of that part has been revised for this edition.

Maryland-Virginia-District of Columbia

WASHINGTON AND VICINITY (road map). Latitude, $38^{\circ} 30'$ to $39^{\circ} 30'$; longitude, $76^{\circ} 30'$ to $77^{\circ} 30'$. Scale, 1 inch=4 miles.

Shaded relief map of the District of Columbia and parts of Maryland and Virginia, including a large section of the Piedmont Upland from Catoctin Mountain on the northwest to the Fall Belt on the southeast and of the Coastal Plain between the Fall Belt and the west shore of Chesapeake Bay. This map does not show contour lines, but the topography is brought out by the shading. The main roads and other improved roads about Washington and Baltimore are indicated by a red overprint. This edition shows a number of changes in roads since the map was first issued in 1923. On the back of the sheet is a brief description of some of the chief geographic, geologic, and historic features of the area.

Missouri

* **CLARKDALE:** Latitude, $39^{\circ} 45'$ to 40° ; longitude, $94^{\circ} 30'$ to $94^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Andrew, De Kalb, and Buchanan Counties, in the Dissected Till Plains. The area is a rolling upland whose general surface stands about 1,100 feet above sea level on the ridges and is cut down to about 850 feet in the main valleys, which have flat floors half a mile or more wide. The upland is rather completely dissected, and little level surface remains on the divides. Platte River flows through the area in a course marked by many small meanders and oxbow lakes.

* **DARLINGTON:** Latitude, 40° to $40^{\circ} 15'$; longitude, $94^{\circ} 15'$ to $94^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Gentry and DeKalb Counties, in northwestern Missouri. Only the southern half of the area bounded by the parallels and meridians indicated is shown. The area is in the Dissected Till Plains section of the Central Lowland and is a rolling upland whose surface lies 1,000 to 1,100 feet above sea level and is cut by small flaring valleys 100 feet deep. Grand River crosses the area in a rather winding course in a flat-bottomed valley that is at places a mile wide.

GILMAN: Latitude, 40° to 40° 15'; longitude, 93° 45' to 94°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Daviess and Grundy Counties (only the southern part of the Gilman quadrangle), in the Dissected Till Plains. The surface stands 940 to 980 feet above sea level on the main divides, where it is little dissected and there is still considerable level land. The main valleys are cut to a depth of about 100 feet, and a few of the larger ones have narrow flood plains.

GOWE: Latitude, 39° 30' to 39° 45'; longitude, 94° 30' to 94° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Buchanan, Clinton, Platte, and De Kalb Counties, in the Dissected Till Plains. The general surface is a rolling upland 1,000 to 1,100 feet above sea level, across which Platte River and its tributaries have cut valleys about 100 feet deep. The upland is thoroughly dissected, and the slopes are everywhere cut by small ravines. The valley of Platte River has a flood plain more than a mile wide at some places, but most of the valleys are V-shaped, with narrow floors. The course of Platte River through most of the area is strongly meandering, and the positions of abandoned meanders are shown by oxbow lakes and sloughs.

PATTONSBURG: Latitude, 40° to 40° 15'; longitude, 94° to 94° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Daviess, Gentry, and De Kalb Counties, in the Dissected Till Plains. Only the southern half of the area outlined has been mapped. The general surface is a rolling upland that descends gently southeastward from 980 to 860 feet above sea level and is dissected by broad flaring valleys 100 to 150 feet deep. Grand River flows across the area in a tortuous course, part of which is on a flood plain several miles wide, with oxbow lakes and abandoned channels.

STANBERRY: Latitude, 40° to 40° 15'; longitude, 94° 30' to 94° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Andrew, Gentry, and De Kalb Counties, in northwestern Missouri. Only the southern half of the area bounded by the parallels and meridians indicated is shown. The area lies in the Dissected Till Plains section of the Central Lowland and is a rolling upland whose surface is 1,000 to 1,100 feet above sea level and is cut by small flaring valleys 100 feet deep. Platte River flows across the area in a flat-bottomed valley 2 miles wide, where its tortuous channel has been artificially straightened to improve the drainage.

Missouri-Illinois

ALTENBURG: Latitude, 37° 30' to 37° 45'; longitude, 89° 30' to 89° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Perry and Cape Girardeau Counties, Mo., and Jackson and Union Counties, Ill., in the southeastern part of the Ozark Upland. The upland surface, which is almost completely dissected by small gullies leading to the broader valleys, stands in general 550 to 650 feet above sea level but exceeds 700 feet at several points along a line of irregular hills that lie 2 to 4 miles west of Mississippi River. Apple Creek and one or two smaller streams flow across the area to the Mississippi in tortuous valleys with narrow flood plains. The Mississippi flows in a valley several miles wide but hugs the west side of the valley, which is lined by bluffs that rise at places more than 100 feet. Opposite Wittenberg and Grand Tower there are bluffs on the east side of the river also. Sink holes are abundant in some parts of the area, and some of the largest occupy many acres and are 60 to 100 feet deep.

New York

DEPOSIT: Latitude, 42° to 42° 15'; longitude, 75° 15' to 75° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Delaware, Broome, and Chenango Counties, in the Allegheny Plateau, which is here so deeply dissected that almost none of the original surface remains and its character as a plateau is not easily distinguishable. The highest hilltops stand 2,300 feet above sea level in the eastern part of the area, but the altitude decreases to 2,000 feet in the western part. Delaware River flows across the area in a sinuous trench about 1,000 feet deep, which has a narrow flood plain in most places. Susquehanna River crosses the northwest corner in a broader valley partly filled with glacial deposits. The area has been strongly glaciated, and several small lakes near the heads of streams high among the hills appear to lie in cirques.

WALTON: Latitude, 42° to 42° 15'; longitude, 75° to 75° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Delaware County, in the Catskill Plateau, which is here so thoroughly and deeply dissected by narrow, gorgelike valleys that its plateau character is almost wholly obliterated. The position of the former surface is probably shown approximately by the small rounded or conical summits of the higher hills, which stand 2,400 to 2,600 feet above sea level in a belt across the middle of the area but are somewhat lower in the northern and southern parts. The East and West Branches of Delaware River flow across the area in sinuous valleys more than 1,000 feet deep, with narrow strips of flood plain along the streams. Several small ponds high among the hills in the southern part of the area occupy hollows that appear to be glacial cirques. The area is striking because of the massiveness of its topographic features, the steepness of its slopes, and the very small proportion of level land. Because of these facts most of the settlements and roads are in the bottoms of the V-shaped valleys.

North Carolina

[See Virginia-North Carolina]

North Carolina-Tennessee

PROPOSED GREAT SMOKY MOUNTAINS NATIONAL PARK: Latitude, 35° 20' to 38°; longitude, 83° to 84°. Scale, 1 inch=2 miles; contour interval, 100 feet.

Map of a part of North Carolina and Tennessee, including the Great Smoky Mountains proper, between Pigeon River, Little Tennessee River, the Chilhowee Mountains, and a part of the Ploft Balsams Range. The proposed park includes the wildest part of the southern Appalachians and some of the grandest scenery. Many of the mountain summits stand more than 5,000 feet above sea level, and Clingmans Dome, the highest peak, is only 31 feet lower than the summit of Mount Mitchell, the highest point in the eastern United States. Mount Guyot, Mount Collins, Jones Knob, and several peaks without names exceed 6,000 feet. The northwestern part of the area, which lies in the valley of east Tennessee, is traversed by the winding courses of Tennessee and French Broad Rivers, and the city of Knoxville is at the extreme northwest corner. The southern and eastern parts lie in the mountain region of western North Carolina but include some partly cleared and settled intermontane valleys.

North Dakota

EDGELEY: Latitude, 46° to 46° 30'; longitude, 98° 30' to 99°. Scale, 1 inch=2 miles; contour interval, 20 feet.

Map of an area in Dickey and La Moure Counties, partly in the Missouri Plateau and partly in the Lake Plains. The western third is an upland tract about 2,000 feet above sea level. The upland is broken by small, irregular ridges and knolls, some of which stand 100 feet above the surrounding area, and by irregular, shallow depressions, some of which contain swamps or ponds. At its eastern margin the surface descends 200 to 300 feet in a mile or so to the western margin of the Lake Plains; the escarpment so formed is known as the Coteau de Missouri. The eastern two-thirds of the area is occupied by a fairly smooth plain, which slopes gently eastward from the base of the Coteau to less than 1,500 feet above sea level and which is well drained, although mainly by intermittent streams.

Ohio

* **DELAWARE:** Latitude, 40° 15' to 40° 30'; longitude, 83° to 83° 15'. Scale, 1 inch=1 mile; contour interval, 10 feet.

Map of an area in Delaware, Marion, and Morrow Counties, in the Till Plains. This map, which is based upon a survey made in 1924, supersedes the edition of October, 1903. The upland surface, which is extremely flat, stands between 930 and 970 feet above sea level, and in the southwestern part of the area a hardly perceptible morainal ridge rises to nearly 1,000 feet. Scioto and Olentangy Rivers, which flow southward across the area, have cut narrow valleys 50 to 100 feet below the till plain, and in the southern part of the area the sides of these valleys are furrowed by many small ravines.

* **EAST COLUMBUS:** Latitude, 39° 45' to 40°; longitude, 82° 45' to 83°. Scale, 1 inch=1 mile; contour interval, 10 feet.

Revised map of an area in Franklin, Fairfield, Pickaway, and Licking Counties, based upon a new survey. The northwest corner includes part of the city of Columbus. The greater part of the area is occupied by a rolling plain whose surface descends from 850 to 700 feet above sea level. Several large creeks cross this plain in winding trenches cut 10 to 50 feet below it. The northeast and southeast corners of the area are occupied by hilly uplands on which several summits stand more than 1,100 feet above sea level.

* **WEST COLUMBUS:** Latitude, 39° 45' to 40°; longitude, 83° to 83° 15'. Scale, 1 inch=1 mile; contour interval, 10 feet.

Revised map of an area in Franklin, Pickaway, and Madison Counties, in the Till Plains, based upon a new survey. The northeast corner includes part of the city of Columbus. The area is a rolling upland whose surface stands 850 to 950 feet above sea level on the broad, flat divides and is cut down to less than 700 feet in the main valleys, which have flat floors about a mile wide on which the rivers meander in broad swings. The valley sides are rather closely furrowed with many small ravines, but a considerable part of the upland surface is only slightly dissected.

Oregon

[See also California-Oregon]

ROGUE RIVER. Plan and profile of Rogue River from mouth to National Creek. Scale, 1 inch= $\frac{1}{2}$ mile; contour intervals, on land 20 feet, on river surface 5 feet; vertical scale of profiles, 1 inch=20 feet (except sheet L, on which 1 inch=80 feet). Size, 21 by 27 inches. 14 sheets (7 plans, 7 profiles).

Sheets A to G show the course of Rogue River and its tributaries with their rapids, islands, and sand flats and the contour of the immediately adjacent slopes. Sheets H to N show the profiles of these streams.

- **STAYTON:** Latitude, 44° 45' to 45°; longitude, 122° 45' to 123°. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in Marion and Linn Counties, in the foothills of the Cascade Mountains at the eastern margin of the Puget Trough. Part of the area is occupied by groups of hills whose summits stand 800 to 1,000 feet above sea level and part by an upland whose rolling dissected surface stands at 600 to 700 feet. In the south-central part is a flat-floored intermontane basin that lies 300 to 400 feet above sea level. The northwestern part lies in the east side of the Willamette Valley, at 100 to 200 feet above sea level.

- **WALDO LAKE:** Latitude, 43° 30' to 44°; longitude, 122° to 122° 30'. Scale, 1 inch=2 miles; contour interval, 100 feet.

Map of an area in Lane and Klamath Counties, in the Cascade Mountains. The whole area is mountainous, with many peaks standing 4,000 to 8,750 feet above sea level. Several streams flow westward to Willamette River in canyons 2,000 to 4,000 feet deep. The eastern part is an irregular upland about 5,500 feet above sea level, which has been glaciated and is dotted by numerous small ponds and two fair-sized lakes. Hanging valleys are abundant on the westward-facing slopes, and some of them head in glacial cirques containing small ponds.

Pennsylvania

[See also West Virginia-Pennsylvania]

- **BRADFORD:** Latitude, 41° 45' to 42°; longitude, 78° 30' to 78° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of McKean County, just south of the New York State boundary, in the Allegheny Plateau. The surface stands about 2,200 feet above sea level in the southern part of the area and rises a little toward the north. In the northern part the plateau is dissected by sharp valleys 500 to 800 feet deep with narrow flood plains; here the nearly level plateau surface remains only as rather narrow strips on the principal divides. In the southern part broad tracts of the plateau surface still remain, and the settlements and main roads are on the plateau instead of in the valleys. To reach the plateau the Buffalo, Rochester & Pittsburgh Railway and the Bradford branch of the Erie Railroad are forced to make a steep and tortuous climb from the valley of the East Branch of Tunungwant Creek. Having gained the plateau, the Buffalo, Rochester & Pittsburgh follows a main divide, but the Erie crosses the deep valley of Kinzua Creek on the Kinzua Viaduct, one of the highest railroad bridges in the country. The famous Bradford oil field occupies much of the northern part of the area, and the southern part lies within the northern margin of the bituminous coal field of western Pennsylvania.

- **CAMBRIDGE SPRINGS:** Latitude, 41° 45' to 42°; longitude, 80° to 80° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Erie and Crawford Counties, chiefly in the Allegheny Plateau. The general surface stands 1,500 to 1,600 feet above sea level in most of the area but descends to about 1,200 feet in the northwestern part, at the crest of the sloping escarpment facing toward Lake Erie. The plateau is trenched by several valleys 200 to 400 feet deep and as much as a mile wide, which are partly choked by glacial drift and have swampy floors at some places. Although the area is within a few miles of Lake Erie the greater part of it is drained to Allegheny River and thence to the Gulf of Mexico. The divide between the Mississippi and St. Lawrence drainage basins crosses the area not far south of the crest of the escarpment.

- **MEADVILLE:** Latitude, 41° 30' to 41° 45'; longitude, 80° to 80° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Crawford County, in the Allegheny Plateau, whose upland surface descends gently from 1,600 to 1,300 feet. The main valleys are 200 to 400 feet deep, and most of them have flat floors half a mile or more wide, some of which are marshy. Some fairly level surface remains on the divides. The valley sides are generally rather steep and are furrowed by small ravines. Some of the valleys are partly choked by glacial moraines.

- **TOWANDA:** Latitude, 41° 45' to 42°; longitude, 76° 15' to 76° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of part of Bradford County, in the Allegheny Plateau, whose general surface stands 1,600 feet above sea level in the northern part of the area and descends gently southward but is so completely dissected that almost no level land remains. Susquehanna River cuts across the extreme northwest corner, flowing southward, then swinging eastward reenters the area and flows across its southwest corner in a sinuous trench with a flat floor about a mile wide that lies a little more than 700 feet above sea level. The valleys of the chief tributary streams are narrow and V-shaped and 300 to 600 feet deep. Evidences of glaciation are seen in the overdeepened cols and the small swamps and ponds on or near the upland divides.

Tennessee

[See North Carolina-Tennessee]

Texas

BUCK HILL: Latitude, $29^{\circ} 45'$ to 30° ; longitude, $103^{\circ} 30'$ to $103^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Brewster County, in the southern part of the trans-Pecos region. The central part is occupied by a broad plain that descends gently from 3,800 to less than 3,600 feet above sea level. The smoothness of the plain is broken by several small buttes at 3,900 to 4,200 feet. The southeast corner is occupied by a hilly region, whose highest points rise to about the same altitude as the buttes. There are other tracts of hilly country in the northern part of the area, and in the northwest corner are two large mesas with summits about 5,000 feet above sea level and bounding escarpments 600 feet or more in height.

* **CORPUS CHRISTI:** Latitude, $27^{\circ} 45'$ to 28° ; longitude, $97^{\circ} 15'$ to $97^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 6 feet.

Map of an area on the coast of Texas in San Patricio and Nueces Counties. It includes Nueces Bay, at the mouth of Nueces River, and a large part of Corpus Christi Bay. The surface is part of the Gulf Coastal Plain, which rises gradually from about 25 to 60 feet above sea level. Corpus Christi Bay is separated from the Gulf of Mexico by an extensive barrier beach that lies east of this area, and from Nueces Bay by spits or hooks built out from both sides. The features about the bays give evidence of a recent uplift of the land; hence the bays are generally bounded by low cliffs instead of marshes, and the shores are regular in outline. Corpus Christi, which faces Corpus Christi Bay on a point of land south of Nueces Bay, is the largest town in the region. It has railroad connection with many points in the interior, and its connection with the Gulf through Aransas Pass has made it a seaport of considerable importance.

OIL AND GAS FIELDS of the State of Texas. Scale, 1 inch=about 12 miles. 2 sheets, each 58 by 38 inches.

New edition of map showing the location and names of the oil and gas fields, salt domes, oil refineries, and pipe lines. The approximate location of the Balcones fault zone is also shown.

* **OSO CREEK:** Latitude, $27^{\circ} 30'$ to $27^{\circ} 45'$; longitude, $97^{\circ} 15'$ to $97^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 5 feet.

Map of parts of Nueces and Kleberg Counties, in the Gulf Coastal Plain of southwestern Texas, on the shore of Corpus Christi Bay and Laguna Madre. The surface is very flat and nowhere stands more than 40 feet above sea level. Ranges of low dunes form the backbone of Padre Island, which separates Laguna Madre from the Gulf of Mexico, and a small group of dunes stands just west of Flour Bluff Point, at the angle between Laguna Madre and Corpus Christi Bay. Other small dunelike knolls occur along the shores of the estuary of Oso Creek, which is almost cut off from Corpus Christi Bay by a narrow barrier beach.

* **ROBSTOWN:** Latitude, $27^{\circ} 45'$ to 28° ; longitude, $97^{\circ} 30'$ to $97^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 5 feet.

Map of an area a few miles west of Corpus Christi, in Nueces and San Patricio Counties, near the extreme southern point of Texas. The upland surface consists of a very perfect plain that slopes from 100 to 45 feet above sea level. This plain is continuous except for the valley of Nueces River, which has an average width of about 3 miles and ranges in altitude from sea level to about 15 feet. The valley bottom is generally swampy, and the river wanders widely but with poorly developed meanders. Instead of entering the bay at its extreme head the river hugs the south bluffs and enters about 4 miles from the bay head, at a point just east of this area.

Utah

* **ACORD LAKES:** Latitude, $38^{\circ} 45'$ to 39° ; longitude, $111^{\circ} 15'$ to $111^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Sevier and Emery Counties, at the southeast margin of the Wasatch Plateau, whose surface stands 8,300 to 9,000 feet above sea level and includes parts of several plateaus. The margin of the plateau is cut by flaring canyons 3,000 feet in depth. The southeastern part of the area lies in Castle Valley, an interior or basin plateau, whose floor lies 6,300 to 6,500 feet above sea level and is crossed in broad, shallow valleys by the streams that flow from the higher plateau.

* **CASTLE DALE:** Latitude, 39° to $39^{\circ} 15'$; longitude, 111° to $111^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Emery County, the eastern half of which lies in Castle Valley. The valley floor slopes gently eastward from an altitude of more than 6,000 feet to about 5,600 feet and is broken by a few small hills and escarpments 300 to 500 feet high. The western part is occupied by outliers of the Wasatch Plateau at different levels. The highest point is The Cap, at 9,600 feet. The plateau is bounded by an escarpment 1,500 to 2,000 feet high, at the base of which lies a belt of much broken country, whose surface descends several hundred feet more to the valley.

DUCHESNE RIVER. Plan and profile of Duchesne River and tributaries. Scale, 1 inch= $\frac{1}{2}$ mile; contour interval, 20 feet; vertical scale of profiles, 1 inch=160 feet. Size, 21 by 27 inches. 6 sheets (3 plans, 3 profiles).

Sheets A to C show the upper courses of Duchesne River and several of its principal tributaries as they flow out from the foothills of the Uinta Mountains. The locations of bench marks, gaging stations, and proposed dam sites are shown, and the relief of belts half a mile to 1 mile wide adjacent to the stream is shown by contour lines. Sheets D to F show the profiles of the streams.

* **HIAWATHA:** Latitude, $39^{\circ} 15'$ to $39^{\circ} 30'$; longitude, 111° to $111^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Emery and Carbon Counties, mainly in the Wasatch Plateau, whose surface reaches 9,600 to 9,800 feet above the sea and is cut by canyons several thousand feet deep. The summits of a range of mountains along the west side of the area stand more than 10,000 feet above sea level. In the southeast corner the surface descends across a broad belt of broken country to an altitude of about 6,000 feet at the edge of Castle Valley.

* **SCOFFIELD:** Latitude, $39^{\circ} 30'$ to $39^{\circ} 45'$; longitude, 111° to $111^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Carbon, Emery, and Sanpete Counties, at the eastern margin of the Wasatch Plateau, which is so thoroughly dissected in this area that hardly any remnants are left. The area is mountainous, and the principal summits stand more than 10,000 feet above sea level; the highest is Monument Mountain, at 10,443 feet. The main valleys, most of which are narrow and canyon-like, are cut to a depth of 3,000 feet or more. At the east side of the area is a part of Castle Valley, an interior or basin plateau, whose floor stands 7,000 to 7,300 feet above sea level and is trenched by several small canyons 300 to 500 feet deep.

Vermont

* **JAY PEAK:** Latitude, $44^{\circ} 45'$ to 45° ; longitude, $72^{\circ} 30'$ to $72^{\circ} 45'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Franklin, Orleans, and Lamoille Counties, extending to the Canadian boundary, a short distance north of the 45th parallel. Most of the area lies in the western range of the Green Mountains. The mountains are rather massive, and a number of peaks stand more than 3,000 feet above sea level. The highest is Jay Peak, which reaches 3,861 feet. Between the mountains lie narrow-bottomed valleys 2,000 to 3,000 feet deep, whose sides are so steep at many places that they merit the name of canyons. Missisquoi River flows across the area in a valley with a flat floor half a mile wide and less than 500 feet above sea level. The area has been heavily glaciated. Some of the drift-choked mountain valleys contain swampy stretches, and little ponds lie high on the mountain slopes.

* **MEMPHREMAGOG:** Latitude, $44^{\circ} 45'$ to 45° ; longitude, 72° to $72^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Orleans County, extending to the Canadian boundary, a short distance north of the 45th parallel. This area lies in the upland of Vermont and is largely occupied by bold hills and small mountains, whose summits stand 1,500 to 2,900 feet above sea level. Scattered among the hills are small patches of rolling upland at 1,300 to 1,400 feet. The upland is cut by valleys 300 to 600 feet deep, some of which have flat floors 1,000 to 2,000 feet wide. The south end of Lake Memphremagog occupies the northwest corner of the area, and several large ponds are situated in the broader valleys. Remnants of kame terraces and possibly of glacial lake beaches are preserved here and there on the hillsides. Several main automobile roads, shown by red overprint, cross the area and meet in the town of Newport, at the head of Lake Memphremagog.

Virginia

[See also Maryland-Virginia-District of Columbia and West Virginia-Virginia]

STATE OF VIRGINIA. Scale, 1 inch=8 miles.

Revised base map of the State of Virginia, printed in two colors. Shows names and boundaries of counties and national forests, towns and most of the smaller settlements, and the railroads (in black), rivers and other water features (in blue).

STATE OF VIRGINIA (power map). Scale, 1 inch=8 miles.

Revised edition of map of Virginia showing by red overprint the location of the hydroelectric and fuel-consuming power-generating stations and transmission lines used in public service in 1925 and the stream-gaging stations.

Virginia-North Carolina

* **DANVILLE:** Latitude, $36^{\circ} 30'$ to $36^{\circ} 45'$; longitude $79^{\circ} 15'$ to $79^{\circ} 30'$. Scale 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Pittsylvania County, Va., and Caswell County, N. C., in the Piedmont Upland. The surface descends gently from somewhat more than 800 feet to somewhat less than 600 feet above sea level. Dan River flows eastward across the southern part of the area in a sinuous valley 150 feet deep, which at places has a flat bottom half a mile wide. The tributary streams have cut valleys somewhat less deep, and they also have narrow flood plains at some places. The northwestern part of the area is crossed by Whiteoak Mountain, several points on whose crest reach altitudes of a little more than 1,100 feet. Danville, in the south-central part, is the principal city.

- * **MARTINSVILLE:** Latitude, $36^{\circ} 30'$ to $36^{\circ} 45'$; longitude, $79^{\circ} 45'$ to 80° . Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Henry County, Va., and Rockingham County, N. C., in the Piedmont Upland, which is here deeply dissected. A little level land remains on the divides here and there, marking the surface of the original upland, which now stands about 1,000 feet above sea level. A few low knobs stand above the general level, and the valleys are cut 100 to 300 feet below it. Smith River flows across the area in a tortuous course. Its valley through most of the area is V-shaped, with no flood plain, but in some places the valley floor has been widened a little.

Virginia-West Virginia

- PROPOSED SHENANDOAH NATIONAL PARK:** Latitude, 38° to 39° ; longitude, 78° to 79° . Scale, 1 inch=2 miles; contour interval, 100 feet.

Map of the region including the proposed Shenandoah National Park, Va., which will cover the part of the Blue Ridge extending from Chester Gap, southeast of Front Royal, to Rock Fish Gap, southeast of Waynesboro. In this part of the Blue Ridge more than 50 summits stand 3,000 feet or more above sea level, and Hawks Bill and Stony Man, the highest peaks, exceed 4,000 feet. Many wild and picturesque gorges cut both slopes of the ridge, which is neither straight nor even-crested. The southern part of the area shown on the map lies in the Piedmont Upland and includes the low ridge of Southwestern Mountain, extending from Orange to Charlottesville. The area is crossed by the Shenandoah Valley, which is diversified by Massanutten Mountain, extending for miles between North Fork and South Fork of Shenandoah River. The northwest corner is crossed by several of the Appalachian Ranges, which are separated by narrow linear valleys. The area thus includes a wide diversity of topographic form, and most of the principal features are visible on a clear day from the higher peaks within the proposed park.

- * **WARM SPRINGS:** Latitude, 38° to $38^{\circ} 15'$; longitude, $79^{\circ} 45'$ to 80° . Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Pocahontas and Greenbrier Counties, W. Va. Only the part of the quadrangle lying in West Virginia has been mapped. The area is situated in the Appalachian Valley and Ranges and is occupied by several parallel northeastward-trending ridges, whose crests stand 2,400 to 4,000 feet above sea level. The ridges are separated by valleys 1,000 to 2,000 feet deep, which have narrow strips of flood plain throughout most of their length. Most of the area is forested.

Washington

- SCHRAG:** Latitude, 47° to $47^{\circ} 15'$; longitude, $118^{\circ} 45'$ to 119° . Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of an area in Adams and Grant Counties, in the northern part of the Columbia Plateaus. The area lies on a lava plateau, which is so much dissected that its plateau character is largely obscured. The general upland surface stands from less than 1,500 to 1,800 feet above sea level. The principal valleys are 250 to 300 feet deep, with fairly steep side slopes, much trenched by ravines, and flat floors one-fourth to one-half mile wide. Although the plateau is so much dissected the present streams are all intermittent.

- WASHTUCNA:** Latitude, $46^{\circ} 45'$ to 47° ; longitude, $118^{\circ} 15'$ to $118^{\circ} 30'$. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of part of Adams County, in the Walla Walla Plateau, whose surface stands about 1,800 feet above sea level. The central and northeastern parts of the area are a nearly level upland slightly trenched by the channels of glacial streams. The southeastern and northwestern parts have a relief of several hundred feet and are rather intricately dissected into a maze of small ridges and ravines which in a great part of the area have a common southwest trend. Several terraces, probably of glacial outwash, are well developed in the valley northeast of Washtucna.

- WHEELER:** Latitude, 47° to $47^{\circ} 15'$; longitude, 119° to $119^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 25 feet.

Map of part of Grant County, in the Walla Walla Plateau, whose surface stands from 1,150 to nearly 1,700 feet above sea level. The northern and eastern parts have a moderate relief and are crossed by several channels formed in part by glacial streams. The southern and western parts are nearly level but descend slightly southward and are diversified by a few small sand dunes and undrained hollows. A westward-facing scarp 75 to 150 feet high at the west edge of the area is the eastern wall of the Grand Coulee.

West Virginia

[See also Virginia-West Virginia]

- BLUEFIELD:** Latitude, $37^{\circ} 15'$ to $37^{\circ} 30'$; longitude, 81° to $81^{\circ} 15'$. Scale, 1 inch=1 mile; contour interval, 50 feet.

The Bluefield quadrangle lies in Mercer County, W. Va., and Bland and Giles Counties, Va., but only the part in West Virginia is shown on this map. The area lies mainly in the Kanawha Hills section of the Allegheny Plateau and is a region of rugged, rather steep-sided hills, many of which have fairly broad, smooth summits 2,300 to 2,600 feet above sea level. Some of the more rugged hills have narrow ridgeline crests that rise to 3,000 feet or more. The most conspicuous is Black Oak Mountain, in the west-central part. The southern part of the area extends to the crest of East River Mountain, the first of the Appalachian Ranges, which stands 3,600 feet above sea level at some points. The main valleys in the plateau

are cut to a depth of 300 feet or more. Bluestone River flows cross the area in an incised meandering valley with narrow strips of flood plain. The area is crossed by the Norfolk & Western and Virginian Railways, and the two chief towns, Bluefield and Princeton, are the concentration points where long trains of coal are made up for shipment to Norfolk. This map was originally issued in 1916. The culture has been revised for this edition.

ENTERPOINT: Latitude, 39° 15' to 39° 30'; longitude, 80° 30' to 80° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Doddridge, Harrison, Wetzel, and Tyler Counties, in the Allegheny Plateau, whose upland surface stands 1,400 to 1,600 feet above sea level but is so completely dissected that practically none of the original plateau remains. The area is a maze of winding sharp-topped ridges separating narrow V-shaped valleys 300 to 600 feet deep. A few of the larger streams have narrow strips of flood plain. Much of the area is a producing oil field, and oil wells are especially numerous about Salem. This map was originally issued in 1903. The culture has been revised for this edition.

LABRSBURG: Latitude, 39° 15' to 39° 30'; longitude, 80° 15' to 80° 30'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Harrison, Marion, and Wetzel Counties, in the Allegheny Plateau. A few remnants of the original plateau stand 1,500 to 1,600 feet above sea level, but in most of the area the surface has been completely dissected by erosion into hogback ridges and sharp-topped hills, separated by narrow V-shaped valleys several hundred feet in depth. Traces of old, high-level valleys with floors half a mile or so in width are preserved in the valleys of West Fork River and its larger tributaries. This map was originally issued in 1902. The culture has been revised for this edition.

FAIRMONT: Latitude, 39° 15' to 39° 30'; longitude, 80° to 80° 15'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of an area in Taylor, Marion, Harrison, and Barbour Counties, in the Allegheny Plateau, which is so thoroughly dissected that little of the original surface remains. If the valleys were filled to the level of the hilltops the surface would stand about 1,800 feet above sea level. Tygart River flows across the area in a sinuous trench about 600 feet deep with narrow strips of flood plain in a few places. The other valleys are V-shaped with steep side slopes. Traces of a former drainage system at a higher level are preserved in the terraces at Fairmont and elsewhere along the main valleys. This map was first issued in 1902. The culture has been revised for this edition.

LOBELIA: Latitude, 38° to 38° 15'; longitude, 80° 15' to 80° 30'. Scale, 1 inch=1 mile; contour interval 50 feet.

Map of an area in Greenbrier, Pocahontas, Webster, and Nicholas Counties, at the south end of the Allegheny Mountains section of the Allegheny Plateau. Across the Greenbrier Plateau, whose rather irregular surface stands 2,200 to 2,400 feet above sea level, Greenbrier River flows in a winding trench 200 feet or more deep, with a narrow flood plain. The greater part of the area is distinctly mountainous. It contains a number of peaks that reach an altitude of more than 4,000 feet, of which the highest is an unnamed peak at 4,524 feet. The northwestern half of the area is rough, densely forested, and uninhabited except at a few lumber camps. The southeastern part is more generally cleared and settled but contains no large towns.

MARLINTON: Latitude, 38° to 38° 15'; longitude, 80° to 80° 15'. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of parts of Pocahontas and Greenbrier Counties, chiefly in the Appalachian Valley and Ranges. The northwest corner is in the Yew Mountains, a rugged part of the Allegheny Plateau, which reaches an altitude of 4,625 feet at one point on Black Mountain. Greenbrier River flows southwestward across the area in a narrow winding trench cut 300 feet or more below the general surface of the Greenbrier Plateau. Traces of abandoned high-level meanders remain here and there along the walls of the trench. The southeastern half of the area is occupied by several parallel mountain ranges separated by narrow valleys 1,000 to 1,500 feet deep. Points along the crest of Middle Mountain stand more than 3,500 feet above sea level, and the culminating points of the other ranges are only a little lower.

***MINCO:** Latitude, 38° 15' to 38° 30'; longitude, 80° to 80° 15'. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in Pocahontas, Randolph, and Webster Counties, at the eastern margin of the Allegheny Plateau. The greater part of the area is occupied by massive irregular mountains with more or less flat-topped ridges and spurs that stand 4,600 to 4,800 feet above sea level in the southern and eastern parts of the area and about 1,000 feet lower in the northwestern part. The main valleys, some of which have narrow strips of flood plain, are 1,000 to 2,000 feet deep. The southeast corner of the area is crossed by Greenbrier River, and a few square miles in this corner lies on the Greenbrier Plateau at an altitude of 2,600 to 2,700 feet.

West Virginia-Pennsylvania

LACKSVILLE: Latitude, 39° 30' to 39° 45'; longitude, 80° to 80° 15'. Scale, 1 inch=1 mile; contour interval 20 feet.

Map of an area in Monongalia and Marion Counties, W. Va., and Greene County, Pa., in the Allegheny Plateau, which is here so deeply dissected that practically none of the original surface remains. The highest hilltops, which probably repre-

sent nearly the position of the old plateau, stand 1,500 to 1,600 feet above sea level in the southern part of the area and somewhat lower in the northern part. The narrow V-shaped valleys are cut to a depth of 500 to 800 feet. The valley of Dunkard Creek, along the State line, contains remnants of an old valley floor lying about 80 feet above the present stream. This is a new edition of the Blacks-ville map showing revised culture for the part in West Virginia.

MANNINGTON: Latitude, 39° 30' to 39° 45'; longitude, 80° 15' to 80° 30'. Scale, 1 inch=1 mile; contour interval 20 feet.

Map of parts of Marion, Monongalia, and Wetzel Counties, W. Va., and Greene County, Pa., in the Allegheny Plateau. The plateau surface has been so completely dissected by the many small, sharply incised valleys and ravines that almost none of it remains, but if it were to be restored by filling the valleys to the height of the hilltops it would stand 1,500 to 1,600 feet above sea level. Some of the larger valleys are 500 to 600 feet deep and have narrow strips of flood plain. Many oil wells are scattered through the central and southern parts of the area. This map was originally issued in 1905. The culture has been revised for this edition.

West Virginia-Virginia

BRAMWELL: Latitude 37° 15' to 37° 30'; longitude, 81° 15' to 81° 30'. Scale, 1 inch=1 mile; contour interval, 50 feet.

Map of an area in McDowell, Wyoming, and Mercer Counties, W. Va., and Tazewell County, Va. This area includes the heart of the celebrated Pocahontas coal field, which was first opened at the town of Pocahontas, but development was soon carried across the ridge to the main field on the head of Elkhorn Creek. The field is served by the Norfolk & Western, Virginian, and Louisville & Nashville Railroads. It lies mainly in the Plateau province, but the southeastern part is in the Appalachian Valley, a region of folded rocks, which, because of the folding, is characterized by ridges trending northeast. Usually the passage from the Appalachian Valley to the Plateau province requires a climb of several hundred feet, but at a point about 5 miles southwest of Pocahontas it is necessary to descend about 300 feet to reach the bottoms of the valleys in the coal field. The coal field was once a sloping plateau whose surface ranged in altitude from about 3,500 feet to about 2,300 feet, but the streams have cut so vigorously that they have destroyed most of the level surface, leaving hills and ridges whose summits are nearly at the level of the old plateau and whose bases are from 800 to 1,500 feet lower. A map of this area was issued in 1911 as the "Pocahontas special." The culture has been revised for this edition.

Wisconsin

* **GAYS MILLS:** Latitude, 43° 15' to 43° 30'; longitude, 90° 45' to 91°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Vernon and Crawford Counties, in the Driftless Area. The general upland stands about 1,200 feet above sea level, and a few low knobs and ridges are about 100 feet higher. Considerable nearly level land remains on the main ridges, whose flanks, however, are rather sharply dissected by many small ravines. The larger valleys are cut to a depth of 400 to 500 feet and have flood plains half a mile wide, on which the streams meander in wriggling curves and which are marked by a number of small oxbow lakes.

* **LA FARGE:** Latitude, 43° 30' to 43° 45'; longitude, 90° 30' to 90° 45'. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Vernon, Richland, and Monroe Counties, in the Driftless Area. The general upland stands 1,200 to 1,300 feet above sea level. The tops of the main ridges are more or less level, but their flanks are dissected by many small ravines. The larger valleys are cut to a depth of 300 to 400 feet and have flood plains less than half a mile wide, on which the streams meander in small curves.

* **VIROQUA:** Latitude, 43° 30' to 43° 45'; longitude, 90° 45' to 91°. Scale, 1 inch=1 mile; contour interval, 20 feet.

Map of parts of Vernon, Monroe, and La Crosse Counties, in the Driftless Area. The general upland stands 1,200 to a little more than 1,800 feet above sea level. Considerable nearly level land remains on the main divides, especially that traversed by the railroad and highway connecting Viroqua and Cashton. The main valleys are cut to a depth of 400 to 500 feet and have flood plains less than half a mile wide. Most of the side valleys and ravines are small and V-shaped.

Wyoming

OIL AND GAS FIELDS of the State of Wyoming. Scale, 1 inch=8 miles (approximately). Size, 41 by 54 inches.

Base map of the State of Wyoming on the scale of 1 to 500,000, without contours, showing, by overprints in several colors, the location of the oil fields, gas fields, anticlinal axes, oil refineries, and trunk pipe lines. The names of most of the anticlines are shown on the map, and an index at the margin gives the location of the named anticlines by townships and ranges and the source of the information.

GEOLOGIC BRANCH

SCOPE AND ORGANIZATION OF WORK

The work of the geologic branch was performed throughout the fiscal year by only two coordinate divisions, the division of mineral resources having been transferred to the Department of Commerce at the end of the last fiscal year. The general organization during the year has been as follows:

Geologic branch: W. C. Mendenhall, chief geologist.

Division of geology: W. C. Mendenhall, geologist in charge.

Division of chemistry and physics: George Steiger, chief chemist, in charge.

APPROPRIATIONS

The acts carrying Geological Survey appropriations for the fiscal year ending June 30, 1926, provide the following amounts for the direct work of the geologic branch:

Geologic surveys-----	\$325, 000
Scientific assistants in the District of Columbia-----	18, 600
Chemical and physical research-----	40, 000
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	383, 600

In addition the geologic field work requisite for the classification of mineral lands was done by means of an appropriation made for the classification of the public lands at a total cost of \$41,800.

DIVISION OF GEOLOGY

ORGANIZATION AND PERSONNEL

The division of geology includes the nine sections indicated below:

Geology of metalliferous deposits, G. F. Loughlin, geologist in charge.

Paleontology and stratigraphy, T. W. Stanton, geologist in charge.

Glacial geology, W. C. Alden, geologist in charge.

Geology of iron and steel metals, E. F. Burchard, geologist in charge.

Coastal Plain investigations, L. W. Stephenson, geologist in charge.

Areal geology, Sidney Palge, geologist in charge (resigned February 28 1926).

Geology of nonmetalliferous deposits, G. R. Mansfield, geologist in charge.

Geology of fuels, W. T. Thom, jr., geologist in charge.

Petrology, C. S. Ross, geologist in charge.

In addition to the units of administrative organization the division includes two advisory committees—the committee on geologic names, T. W. Stanton, chairman, and the physiographic committee, M. R. Campbell, chairman. These committees consider in detail all problems falling within their respective fields and advise the chief geologist of their findings as a basis for administrative action.

The division also exercises technical supervision over the section of geologic map editing, through G. W. Stose, geologist in charge, and administrative control over the observatory at the Volcano House, Hawaii, of which T. A. Jaggard, jr., is in charge.

At the beginning of the fiscal year the division included 108 geologists of various grades. During the year 4 resigned, 2 died, 4 were transferred, and 5 were added to the staff, so that the number on the rolls at the end of the year was 103. The division included 4 draftsmen (1 temporary) and 5 preparators of fossils. In the clerical

cal and messenger force there was 1 accession and 4 separations, leaving a total of 28 at the end of the year (26 permanent and 2 temporary).

David White was on leave without pay from July 8 to the end of the fiscal year, with the exception of brief periods in November and June, to act as chairman of the division of geology and geography of the National Research Council.

Sidney Paige, who had charge of the section of areal geology, resigned February 28 to accept a position with the Amerada Corporation for work in South America.

F. L. Hess was transferred on August 10 to the Bureau of Mines.

W. T. Lee died June 16, 1926.

J. B. Woodworth died August 4, 1925.

H. D. Miser was granted a furlough beginning August 29 for the remainder of the fiscal year to take over the duties of State geologist of Tennessee.

E. F. Burchard was granted leave without pay for four months from July 6, 1925, to examine deposits of iron ore in Argentina for the Argentine Government.

Arthur Keith was on leave without pay for two months from March 17, delivering a course of lectures at the University of Texas.

Edward Sampson, having joined the geologic staff at Princeton University, was placed in a per diem status September 27.

Geologists D. F. Hewett, Julia Gardner, M. I. Goldman, E. O. Ulrich, and H. G. Ferguson attended the Fourteenth International Geological Congress at Madrid, Spain.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the division of geology for the fiscal year were as follows:

Geologic surveys.....	\$325, 000
Classification of lands	41, 800
Scientific assistants.....	14, 600
Search for potash deposits (allotted from appropriation for chemical and physical research).....	3, 850
Repayments from other departments.....	970
Repayments from States and cities.....	3, 240
	<hr/>
	389, 460

The expenditures from these funds may be classified by subjects approximately as follows:

Hawaiian volcanology	\$11, 650
Geology of metalliferous deposits.....	60, 000
Geology of nonmetalliferous deposits.....	11, 000
Geology of fuels (oil, gas, coal).....	79, 000
Scientific researches not directly connected with economic geology, etc	128, 960
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc.....	96, 350
Budget reserve and unexpended balance.....	2, 500
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	389, 460

Of the amounts available for geologic work approximately \$95,000 was used directly to pay field expenses. About 73 per cent of this amount was expended for work west of the one-hundredth meridian and about 27 per cent for work east of it.

COMMITTEE ON GEOLOGIC NAMES

The committee on geologic names, under the chairmanship of T. W. Stanton, reviews the geologic manuscripts submitted for publication, advises authors and other inquirers as to established nomenclature, and through its systematic accumulation of records of the use of geologic names performs an essential service in preventing confusion in this vexing field. Under the direction of the chairman the secretary of the committee, Miss M. G. Wilmarth, has prepared a number of charts indicating the current ideas of correlation in particular regions. These charts have been photolithographed and distributed widely to working geologists, to whom they have been of much assistance in the solution of local problems and in the use of the voluminous existing literature.

PHYSIOGRAPHIC COMMITTEE

The physiographic committee, under the chairmanship of M. R. Campbell, continued to review the manuscripts of papers dealing with geography and physiography and the use of technical terms therein, and to accumulate material for a revision of the physiographic divisions of the United States. It also is the source of information supplied to inquirers on geomorphic subjects and on the particular topographic maps that are best suited for use in teaching.

THE WORK IN GENERAL

In numberless ways, many of them most obvious, others but obscurely discernible, the Nation is still feeling the surge of the World War. One of the less widely recognized, perhaps, of these many after-effects is the recognition of the value of science which has spread through industry in recent years. Scientists and industrial leaders became acquainted by working side by side in a common cause through 1917 and 1918. Each learned to respect the contribution that the other made to the solution of the acute and vital problems of the time. When the crisis was over, many leaders of industry went home with a greatly enhanced respect for "research" and for the men engaged in it. They had found that these men were human beings, with no special endowments, perhaps, but with special knowledge and training and a surprising capacity to use them in practical ways. The more alert among the business leaders promptly utilized this experience, and as a result industrial laboratories and scientific staffs in industry have greatly multiplied since the war. Furthermore, these leaders are now manifesting a sympathy with research in general and a desire to foster it, with full confidence that the results will be of value. Prior to this experience science and scientists had been to them vague terms, connoting something queer and impractical, to be tolerated perhaps because an inscrutable power for some mysterious reason had placed them on earth but not entering at all into everyday affairs.

For the time being, at least, that state of mind has passed. Science and research are in demand. But the demand is often em-

barrassing. The understanding acquired by the industrial leaders is not complete. There is still something of the commercial tendency to order a piece of research by telegraph for delivery next day—to expect the scientist to answer on the instant a question that he may be able to answer after a year or a lifetime of work. Yet scientific results are wanted—more generally and more intelligently and more insistently than a decade ago.

The Geological Survey recognizes and would like to respond to this changed and changing attitude. In its field it continues, with the staff and the means available to it, to endeavor to do sound work and to follow sound principles. In geology three main trends may be recognized in its endeavors, although these may all merge in individual projects. First, it seeks to devote some of its energies to the establishment of principles and the discovery of new generalizations and new laws of wide applicability. These new discoveries may be made in the field of petroleum geology, or the geology of the metals, or glaciology, or paleontology, or seismology. But, once established, they are sure to have wide applicability either in industry or in the more general field of man's intelligent adaptation to his environment. Second, it endeavors continually to make known new facts. These may take the form of a geologic map, which thereafter becomes the guide of the metal miner or the petroleum engineer or the teacher. Or they may be set forth in a report describing and illustrating the extinct life of a past epoch, and this enables the commercial geologist to determine the relative ages of the rocks with which he has to deal. To an oil-company geologist or a mining engineer such a report may be like a road map to a tourist. These are perhaps indirect services to the mining industry, but finally it also endeavors to serve this industry directly in its economic reports, which may describe in detail the character, quality, and exact position of deposits of rock phosphate, or coal, or building stone, or petroleum. Such reports are immediate guides to mining and are the basis for the detailed work in local areas of the company geologist or engineer.

In none of these three lines of endeavor is the Geological Survey doing all the work that, as a long established scientific bureau, it should do or is expected to do. The multiplication of commercial geologists who are applying the science in industry multiplies the demands for fundamental science to apply. More paleontology is wanted, more sound geologic mapping, more and better bases for correlation, more understanding of the processes of ore deposition, more broad structural studies, more knowledge of the geologic reasons underlying earthquake activity. Something, but by no means enough, is done in these various fields which the Geological Survey is properly expected by the scientific and the lay public to occupy. The work of the year is outlined below in some detail by States, but a few of its salient features may be summarized here.

The preparation of State geologic maps, usually in cooperation with the State organizations, continues. The map of Alabama, prepared in cooperation with Dr. E. A. Smith, State geologist, for publication by the State, was in press at the end of the year; and those of Oklahoma and New Mexico were completed and are in

process of publication by this organization. Systematic progress is being made on the map of Texas, with the cooperation of the State Geological Survey and the active geologists in the State. All these state maps will contribute to a new geologic map of the United States, which is planned for issue eventually.

Guides to ore in the Leadville district, Colorado, by G. F. Loughlin, as issued as Bulletin 779. It contains a summary of the results of the work of Emmons, Irving, and Loughlin that will appear in full in Professional Paper 148, which went to the Public Printer in May. This short report attempts to present briefly and succinctly the facts and the suggestions of most value to operators that have resulted from the studies of the past.

A study of the deeper workings in the Mother Lode district of California that have been opened since the earlier investigations of that district by Lindgren and Ransome was completed during the year by Adolph Knopf. The report, prepared in cooperation with the State mineralogist and embodying the results of these investigations, is in hand. Another important report in the metalliferous field, completed during the year, is one by B. S. Butler and W. S. Urbank on the copper deposits of Michigan. This report embodies the results of several years' intensive study by Mr. Butler, at first under private auspices but later under the direction of the Geological Survey.

Detailed studies of western coal fields, including the North Shoshone field in Montana, the Wasatch Plateau fields in Utah, and the Hanna and Carbon Basin fields in Wyoming, were continued.

The structural and economic studies in the Goodsprings, Lancaster, and Walker Lake regions of the Great Basin were advanced. Similar work was done in Idaho on phosphate deposits and in Cooke City, Mont., on metalliferous deposits. A reconnaissance of the promising manganese deposits of the Olympic Peninsula, Wash., was made and a brief report prepared.

The region of the Montana earthquake of June 27, 1925, was examined geologically, and a report on it is in press. A brief press statement has also been issued summarizing the results of field studies of the New England earthquakes of 1924 and 1925.

The examination of cuttings from oil wells in western Texas and eastern New Mexico has continued as a part of the search for commercial potash deposits. A Federal appropriation of \$100,000 was made toward the end of the year for core drilling in areas that may be recommended as a result of the work of the United States Geological Survey during the last decade and more, so that quantitative data may soon be expected to supplement the merely qualitative information heretofore available.

Suggestive papers have been prepared by Messrs. Van Orstrand and Thom on the structural significance of earth temperatures measured by Mr. Van Orstrand in some of the western oil fields. The oil industry is interested in this subject, and work by the Geological Survey is likely to be supplemented in the future by work done under private auspices.

In the physical laboratory Mr. Nutting suggested to the oil operators of Bradford, Pa., a modification of the water drive by the introduction of a soda solution which, under laboratory conditions,

separates the oil from the sand grains and results in a clean drive and a full recovery of oil. The experiment is now being tried in the field, and the results will be watched with great interest.

E. O. Ulrich studied many of the European Paleozoic sections in July, August, and September, 1925, in consultation with European geologists and paleontologists. This work was done in connection with his studies of the North American Paleozoic, especially for the light it might throw on his proposed Ozarkian and Canadian systems.

The work at the Hawaiian Volcano Observatory was continued throughout the year, and Congress made provision for the expansion of this work during the next fiscal year. Kilauea Volcano was quiescent during the year, but a spectacular eruption of Mauna Loa took place in April, 1926.

COOPERATION

Cooperation with a number of State surveys and other official organizations continued throughout the year.

The Colorado Metal Mining Fund cooperated in a survey of the deeper levels at Cripple Creek and entered into an agreement for more extensive cooperation in a general geologic survey of the known and possible mineralized areas of the States.

Cooperation with the State geologist of Florida was effected for the purpose of revising the geologic map of the State and the report on its geology and water resources. The Geological Survey also cooperated with the Smithsonian Institution in an investigation of reported prehistoric human remains in Florida.

The revision of the geologic map of Alabama and the preparation of the accompanying text were undertaken jointly by members of the State and Federal survey staffs. The work was nearing completion at the end of the year.

The systematic cooperation with the State geologist of Kansas on oil and gas problems and on the preparation of a State map was continued, and similar relations were maintained with the Texas State Survey.

The California Mother Lode report, the field work on which was cooperative, was submitted at the end of the year.

Progress was made on the Pend Oreille and other cooperative reports in Idaho, and minor cooperation was effected with Connecticut and Pennsylvania. Other cooperation was carried out with the National Academy of Sciences, the Hawaiian Research Association, the Office of Indian Affairs, the Bureau of Mines, and the cities of Detroit, Mich., and Clifton Forge, Va.

WORK OF THE YEAR BY STATES

ALABAMA

Charles Butts prepared a paper embracing a statement of new discoveries in the Devonian rocks of Alabama for presentation before the Geological Society of Washington and publication in a scientific journal. A press bulletin was prepared by Mr. Butts on the extent of the Montevallo coal bed of the southern part of the Cahaba coal field, to settle the identity of the coal bed mined at the Straven mine, Straven, Shelby County, and he revised the economic portion of the Bessemer-Vandiver folio. The geologic map of Alabama and accompanying descriptive text prepared in cooperation with the

State Geological Survey have been completed and will soon be ready for distribution by the State. Mr. Butts, L. W. Stephenson, and C. W. Cooke, representing the United States Geological Survey, mapped the Paleozoic, Tertiary, and Quaternary formations, and G. I. Adams, representing the State, mapped the crystalline rocks. Mr. Cooke prepared a paper on the correlation of the Eocene formations of Mississippi and Alabama. G. H. Girty continued the preparation of a paper on the Carboniferous fauna from the town of Trinity.

Publications: Bulletin 781-A; Professional Paper 140-E; Press Notice 5989, "The extent of the Montevallo coal bed of the southern part of the Cahaba coal field, Ala."

ARIZONA

M. N. Short completed an article on ore deposition and enrichment at the Magma mine, Superior, Ariz., of which I. A. Ettlinger is coauthor, for publication in the Transactions of the American Institute of Mining and Metallurgical Engineers. The Permian of Arizona and New Mexico was the subject of a paper by N. H. Darton prepared for publication in the Bulletin of the American Association of Petroleum Geologists. F. E. Matthes wrote an article on the map of Grand Canyon National Park, in collaboration with R. T. Evans, of the topographic branch, which was published in the Military Engineer. A paper on structural studies in southern Nevada and western Arizona, by C. R. Longwell, was presented at the annual meeting of the Geological Society of America and offered for publication by that society.

Publications: Bulletin 771; Professional Paper 140-B; Press Notices 6332, "Mastodons and glyptodonts in San Pedro Valley." and 2110, "Aravaipa and Stanley mining districts."

ARKANSAS

L. W. Stephenson continued the preparation of a report on the stratigraphy of the Upper Cretaceous formations of Texas, Oklahoma, and Arkansas and presented at the Dallas meeting of the American Association of Petroleum Geologists a paper on this subject, which was subsequently revised for publication in the bulletin of that association. J. B. Reeside, jr., examined and reported on a small collection of fossil ammonites from the Brownstown marl for Mr. Stephenson. The Cretaceous rocks in southwestern Arkansas, embracing parts of Sevier, Little River, Howard, Hempstead, Clark, Nevada, and Pike Counties, were mapped by C. H. Dane, assisted by Paul D. Torrey, after a preliminary reconnaissance of the area with L. W. Stephenson and H. D. Miser. Later Mr. Stephenson and Mr. Dane made a field trip for the purpose of reviewing the geology of the area and correlating the formations with those of northeastern Texas. Mr. Dane began a report on the areal geology and stratigraphy of the oil-bearing Cretaceous formations of southwestern Arkansas and prepared a press notice on the stratigraphy. H. D. Miser, C. S. Ross, and L. W. Stephenson continued work on a report on the volcanic rocks in the Upper Cretaceous of southwestern Arkansas, northeastern Texas, and southeastern Oklahoma. Messrs. Miser and Ross prepared a note on the discovery of pre-Cambrian rhyolite in a well in northwestern Arkansas, for publication in the Bulletin of the American Association of Petroleum Geologists. A report on the fauna of the lower Boone at Batesville, Ark., was completed by G. H. Girty.

CALIFORNIA

Field work in the Alleghany mining district, Calif., was completed by H. G. Ferguson, assisted by R. W. Gannett, and some progress was made on a report on the geology and ore deposits of the district; F. H. Knowlton reported on the Miocene plants. F. E. Matthes made a physiographic reconnaissance of the Kings and Kaweah drainage basins, including the Sequoia National Park. Mr. Matthes revised his professional paper on the origin of Yosemite Valley, continued work on his report on the physiography of the upper San Joaquin basin, completed a paper on the glaciation of San Jacinto Peak for publication in Science, and prepared an article on Kings River canyon and Yosemite Valley for publication in the Bulletin of the Sierra Club. Plants of the Burnham Chemical Co., American Trolva Corporation, and Inyo Chemical Co. and deposits of borax and bentonite near Shoshone were visited by G. R. Mansfield and L. F. Noble, and Mr. Mansfield also visited the Red Mountain

magnesite mine, east of Livermore. Mr. Noble continued field and office study of the San Andreas rift and of the nonmetalliferous minerals of the southern part of the State. He prepared papers on the borate deposits at Kramer, Kern County, and a colemanite deposit near Shoshone, with a sketch of the geology of a part of Amargosa Valley. Adolph Knopf completed his report on the resurvey of the Mother Lode district. C. P. Ross visited quicksilver mines in California. W. P. Woodring and P. V. Roundy continued work on their report on the geology and oil resources of the Elk Hills district, and Mr. Woodring prepared an article on Pliocene *Viviparus*-like opercula from California for publication in *Nautilus*. H. W. Hoots completed field work on the Wheeler Ridge oil field and adjacent areas at the south end of San Joaquin Valley and has submitted a partial report on these areas to the conservation branch. Mr. Hoots also did structural mapping in the Salinas Valley, in Monterey County, and submitted a report to the conservation branch. W. S. W. Kew prepared an article on the geology of the San Pedro Hills, based on work done while he was a member of the Geological Survey, for publication by the Los Angeles Chamber of Mines and Oil. T. W. Stanton identified Cretaceous fossils from southern California for the San Diego Museum of Natural History and reported on Cretaceous invertebrates for R. B. Steward.

Publication: Bulletin 768.

COLORADO

G. F. Loughlin, assisted by J. C. Beam and T. S. Lovering, studied the deep mines in the Cripple Creek district, and Mr. Loughlin completed a report on "Guides to ore in the Leadville district" (Bulletin 779). B. S. Butler and Mr. Lovering prepared for a study of the mining geology of Colorado, to be commenced in the next fiscal year in cooperation with the Colorado Metal Mining Fund. E. S. Larsen, assisted by John W. Vanderwilt, reviewed the geology of a portion of the San Juan Mountains. The manuscript of a report on the Quaternary geology and physiography of the San Juan region by W. W. Atwood and K. F. Mather was completed. Mr. Atwood prepared an article on the utilization of a rugged mountain region, based on a survey of the San Juan Mountains, for publication in *Economic Geography*. Stratigraphic work on the Book Cliffs and Grand Mesa was done by E. M. Spieker and J. B. Reeside, jr., as part of a study of the Mesozoic and Tertiary formations exposed along the Book Cliffs between Woodside, Utah, and Palisade, Colo. Mr. Reeside examined Cretaceous and Tertiary fossils collected in the Book Cliffs and adjacent regions, Utah and Colorado, by Mr. Spieker and himself in 1925; late Pierre fossils for Prof. J. Harlan Johnson, of the Colorado School of Mines; and Cretaceous fossils collected in 1924 in northeastern Colorado by K. F. Mather and party. A report on the oil and gas resources of northeastern Colorado, by Mr. Mather, James Gilluly, and R. G. Lusk, was completed and transmitted for publication.

Stratigraphic work in connection with coal and oil land classification in western Colorado (Montrose County) and southeastern Utah was done by W. T. Lee, assisted by Paul Torrey, W. W. Boyer, and George Hansen. Mr. Lee and W. T. Thom, jr., studied critical sections within this area. F. H. Knowlton reported on Cretaceous plants from western Colorado for Mr. Lee. A press notice on oil possibilities of southwestern Colorado and southeastern Utah was prepared by Messrs. Thom, Lee, Boyer, and Gilluly. W. H. Bradley, assisted by R. D. Ohrenschall, made stratigraphic studies of the Green River oil-bearing shale in eastern Utah and northwestern Colorado and continued the preparation of reports on the stratigraphy of the Green River formation in Colorado and Utah and on the alga reefs and oolites of the Green River formation. M. R. Campbell, assisted by N. W. Bass and during June, 1926, by K. K. Landes, continued structural and stratigraphic work in the Daton Peak, Pilot Knob, and Mount Harris quadrangles and in Routt County, as a basis for the continuation of the report on the eastern Yampa coal field begun by J. B. Eby. Mr. Campbell prepared reports on oil-prospecting applications for lands in southern Routt County, and N. W. Bass a report on coal in the Pilot Knob quadrangle, for the conservation branch. Mr. Bass gathered data relative to development on the Hamilton, Iles, and Morapos domes and in the Florence, Boulder, Fort Collins, and Wellington oil fields and Wray gas field. He made geologic examinations for the conservation branch as to oil possibilities in T. 5 N., R. 58 W., near Fort Morgan; and in T. 5 S., R. 42 W. W. C. Alden made field studies of the physiography and glacial geology of parts

of Jackson and Routt Counties. A paper on cancrinite as a high-temperature hydrothermal mineral from Colorado was written by E. S. Larsen and W. F. Foshag for publication in the *American Mineralogist*. C. E. Erdmann, assisted by W. D. Johnston, jr., C. J. Peterson, Seth Ritchey, and O. R. Sherman, under the direction of C. E. Dobbin, began a field study of the stratigraphy and structure of the coal and oil shale along the Book Cliffs in the vicinity of Grand Junction.

Publications: Bulletins 757, 777, 779, and 785-A; Professional Paper 138: Press Notices 2205, "Coal resources in Moffat County," 6332, "History of the metal-mining industry in Colorado," and 6064, "Possibility of finding oil in southeastern Utah and southwestern Colorado."

CONNECTICUT

Mrs. E. B. Knopf began a field and office study of the crystalline schists in northwestern Connecticut in cooperation with the Connecticut State Geological and Natural History Survey.

DISTRICT OF COLUMBIA

M. R. Campbell, C. K. Wentworth, C. W. Cooke, and Laurence LaForge studied terrace deposits and underlying sedimentary deposits of the District of Columbia, and Arthur Keith and Mr. LaForge studied and obtained geologic data from excavations being made in Washington.

FLORIDA

Julia Gardner completed her report on the Tellinacea, Solenacea, Mactracea, Myacea, and Molluscoidea of the Alum Bluff group of Florida and prepared a paper on the nomenclature of the superspecific groups of *Corbula* in the lower Miocene for publication in *Nautilus*. W. C. Mansfield collected fossil material from the Choctawhatchee formation between Ocklockonee and Choctawhatchee Rivers and south and southwest of Tallahassee, determined the stratigraphic relations and geographic extent of the formation, and continued office work on his report. C. W. Cooke studied the occurrence and stratigraphic position of vertebrate fossils near Melbourne, on the east coast, and near St. Petersburg, on the west coast, in cooperation with the Smithsonian Institution, and prepared a paper on the occurrence of fossil man and Pleistocene vertebrates in Florida for publication in the *American Journal of Science*. He also did field work for a revision of the report on the geology and water resources of the State and the State geologic map, in cooperation with the Florida Geological Survey.

GEORGIA

C. W. Cooke collected fossil vertebrate remains from the Ocala limestone, near Cordele, Ga., for the National Museum.

IDAHO

Preparation of the cooperative report on the Pend Oreille district, Idaho, was continued by Edward Sampson and J. L. Gillson, and Mr. Gillson wrote a paper for unofficial publication on the granodiorites of the district. The report on the Wood River region of the Hailey quadrangle, by C. P. Ross, L. G. Westgate, and J. B. Umpleby, with a description of the Minnie Moore and neighboring mines, by D. F. Hewett, was completed. Mr. Ross, assisted by W. H. Newhouse and later by C. H. Behre, continued field investigations in the Casto quadrangle and began a report covering these investigations. G. R. Mansfield, assisted by W. B. Lang, studied the geology and mineral resources of the Paradise Valley, Portneuf, and Ammon quadrangles. While in this area they made a trip to Mackay and the Craters of the Moon National Monument; visited the Anaconda Copper Mining Co.'s phosphate mine at Conda, near Soda Springs; and made a trip to King Hill and vicinity to see a reported nitrate deposit. Mr. Mansfield has nearly completed a paper on the geology and phosphate deposits of the Portneuf quadrangle. Reports on collections of fossils from Idaho were made by Messrs. Girty, Kirk, Knowlton, W. C. Mansfield, Roundy, and Stanton. Publications: Bulletins 774 and 780-D; Professional Paper 140-A; Press Notices 4088, "Promising Idaho copper district," and 6332, "Antimony and quicksilver in central Idaho."

ILLINOIS

C. E. Siebenthal accompanied H. A. Buehler, State geologist of Missouri, and J. E. Spurr, of the Engineering and Mining Journal-Press, on a reconnaissance trip during which the lead, zinc, and fluorspar deposits of southern Illinois were studied in company with R. C. Allen and John T. Fuller.

Publication: Geologic Folio 220.

INDIANA

Frank Leverett extended his glacial studies in Ohio Valley to the vicinity of Madison, Ind. G. F. Loughlin spent 10 days in the Bedford-Bloomington region, studying the latest developments in the Indiana oolitic limestone quarry industry, and continued work on his Indiana limestone report.

IOWA

In company with Prof. G. F. Kay, State geologist of Iowa, and Paul MacClintock, of the University of Chicago, Frank Leverett made a reconnaissance of the several glacial drift sheets of Iowa. Mr. Leverett prepared a paper on the present status of the Iowan problem for the American Association for the Advancement of Science. W. T. Thom, jr., made a reconnaissance examination of the oil possibilities in the vicinity of Hamburg. M. R. Campbell examined some coal mines in Taylor County. G. H. Girty and P. V. Roundy spent three days in field work on the Permian of Iowa; Mr. Girty continued office studies of the Kinderhook fauna, and Mr. Roundy continued studies of outcrop material in connection with his studies in micropaleontology. W. W. Rubey spent a brief period in Iowa and Nebraska, examining outcrops along Missouri River near Sioux City, the type locality of the Dakota sandstone.

KANSAS

N. W. Bass continued cooperative work in Kansas and revised the report on oil and gas possibilities in the western part of the State, with special reference to Ellis and Hamilton Counties, to be published as Bulletin 11 of the Kansas Geological Survey, also papers on the asymmetry of Kansas stream valleys, structure and limits of the Kansas salt beds, and geologic structure of the Dakota sandstone. He also studied the results of recent drilling, examined well cuttings from western Kansas, and collected and compiled data relating to subsurface conditions in eastern Kansas, especially as regards the structure of the surface of the Mississippian limestone. In continuation of the cooperative work with the Kansas Geological Survey, Mr. Bass compiled data on Cowley County for use in an investigation of its oil and gas possibilities, which involved field mapping of the geology, plotting logs of wells, and holding conferences with R. C. Moore, State geologist, and oil-company men. Well cuttings and outcrop material from Kansas were examined by P. V. Roundy, and Carboniferous material by G. H. Girty. Messrs. Girty and Roundy spent seven days in field work on the Permian of eastern Kansas.

KENTUCKY

Frank Leverett continued his studies of the Pleistocene geology of Kentucky for the Kentucky Geological Survey, examining glacial drift and associated deposits near Camp Knox and making a study of deposits in Hart County in company with the State geologist. C. E. Siebenthal accompanied H. A. Buehler, State geologist of Missouri, and J. E. Spurr, of the Engineering and Mining Journal-Press, on a reconnaissance trip, during which the lead, zinc, and fluorspar deposits of western Kentucky were studied in company with R. C. Allen and John T. Fuller.

LOUISIANA

C. H. Dane made stratigraphic studies in northern Louisiana, collected development data in the Monroe gas field, the Urania field in T. 10 N., R. 2 E., and the Lockport area in T. 10 S., R. 9 W., and prepared reports on these areas for the conservation branch. P. D. Torrey examined tracts in the Cotton Valley field for land classification. T. W. Stanton reported on Cretaceous fossils from deep wells in Caddo Parish for A. F. Crider.

MAINE

Office work on the folio covering the Portland quadrangle was continued by Laurence LaForge.

MARYLAND

G. R. Mansfield examined a deposit of diatomaceous earth on Patuxent River west of Dunkirk, Md. Field and office work in connection with reports prepared cooperatively with the Maryland Geological Survey for Carroll and Frederick Counties was continued by Miss A. I. Jonas. C. K. Wentworth, accompanied a part of the time by M. R. Campbell, examined terraces and gravel deposits of Pliocene and Pleistocene age in Maryland. W. C. Mansfield spent a few days in the vicinity of Langleys Bluff examining Miocene and Pleistocene deposits. He has in preparation a short paper on spiral forms collected by L. W. Stephenson from Langleys Bluff and a paper on Pleistocene mollusks from Walles Bluff and Langleys Bluff.

MASSACHUSETTS

The field mapping of the Greylock and Berlin quadrangles, Mass., was continued by L. M. Prindle, who made some progress in the preparation of the Taconic folio, covering these quadrangles. Mrs. E. B. Knopf was in the field a few days collaborating with Mr. Prindle. The Boston folio was completed by Laurence LaForge.

MICHIGAN

Field work on the Michigan copper district was completed by B. S. Butler, assisted by W. S. Burbank, and the report on it was transmitted. F. E. Matthes was detailed to make an investigation of geologic formations in the vicinity of Detroit in order to advise the Detroit City Department of Water Supply regarding the construction of a new intake tunnel. G. H. Girty reported on Carboniferous fossils from Michigan.

MINNESOTA

A report on the surface geology of Minnesota and adjacent districts was completed by Frank Leverett. T. W. Stanton identified Cretaceous invertebrates from Minnesota.

MISSISSIPPI

L. W. Stephenson and C. W. Cooke revised the manuscript and map of a cooperative report on the ground waters of Mississippi. A paper on the correlation of the Eocene formations of Mississippi and Alabama, for publication by the Geological Survey, and one entitled "New species of the Eocene mollusks from Jackson," for publication in the Journal of the Washington Academy of Science, were prepared by Mr. Cooke.

Publication: Bulletin 781-A.

MISSOURI

C. E. Siebenthal accompanied H. A. Buehler, State geologist of Missouri, and J. E. Spurr, of the Engineering and Mining Journal-Press, on a reconnaissance trip visiting the pegmatite in Camden County, the lead-zinc mines of the Tri-State district, the outcrops of igneous rocks and copper prospects at Eminence, the iron deposits at Iron Mountain and Pilot Knob, the old Silver mine with gangue carrying wolframite, the lead-copper-cobalt-nickel deposits at Fredericktown, the disseminated lead deposits of the St. Joseph Lead Co. at Bonne Terre, and the barytes workings and mill at Old Mines. R. D. Mesler studied collections of Upper Cambrian and Lower Ordovician fossils from Missouri. G. H. Girty worked on a report on a sink-hole fauna from Missouri and examined Carboniferous fossil material.

MONTANA

A. A. Baker, assisted by C. E. Erdmann, A. J. Bauerschmidt, H. H. Chen, J. M. Dunning, Harry Burnside, and J. C. Beam, continued a field study of the geology and coal resources of the part of the northern extension of the Sheridan coal field, Big Horn and Rosebud Counties, Mont., east of Tongue

River, and revised a previously written report thereon, incorporating results of the field work of 1925. He prepared for the conservation branch reports covering a number of townships east of Tongue River. W. T. Thom, jr., reviewed the structure of the Cat Creek field, collected geologic data from oil companies in Billings, made a reconnaissance of the structure north, west, and south of the Crazy Mountains, and with J. B. Reeside, jr., devoted a little time to work on the Bearpaw-Lance stratigraphic relations near Wyola. Mr. Thom revised a structure contour map of eastern Montana prepared jointly with C. E. Dobbin and wrote an abstract of a paper on the origin of the structural features of eastern Montana, which was presented at the meeting of the Geological Society of America in December, 1925. A. J. Collier, assisted by J. M. Dunning, examined and classified coal land southeast of the Bearpaw Mountains, north of Missouri River; examined the Bowes dome, south of Chinook, and the gas well 25 miles northeast of Chinook, in T. 35 N., R. 21 E.; and reexamined the south side of the Bowdoin dome, Phillips and Valley Counties. Assisted by J. C. Beam, Mr. Collier worked in the Little Rocky Mountains, reviewing the geology and constructing a topographic map of the part of the mountains not covered by the Fort Belknap Indian Reservation. In the office Mr. Collier began the revision of a report on the oil and gas possibilities of the Kevin-Sunburst district and of the Sweetgrass arch, prepared a revised press notice on this field, and wrote an informal report on the coal south of Bearpaw Mountains and north of Missouri River, for the conservation branch.

In connection with a study of the earthquake of June 27, 1925, and the bringing up to date of the report by D. D. Condit and E. H. Finch on the phosphate deposits in the Three Forks-Yellowstone Park region, J. T. Pardee examined an area of about 7,500 square miles south and west of Bozeman and between Great Falls and Bozeman; wrote a report for official publication on the Montana earthquake of June 27, 1925, an abstract of which was submitted for publication in the Special Bulletin of the Seismological Society of America and also Science Service; and began a paper on post-Tertiary faults of southwestern Montana. An examination of Tps. 1 N. and 1 S., R. 7 E., Gallatin County, for coal classification was made by Mr. Pardee, who prepared reports for the conservation branch. R. S. Knappen revised his report on the oil resources of the northern Big Horn Basin. A report on the New World (Cooke City) mining district, Park County, was completed by T. S. Lovering. Frank Reeves continued his work on the areal and structural geology of the Bearpaw Mountains and revised a report on the Cat Creek and Devils Basin oil fields. W. W. Rubey prepared geologic and topographic maps of portions of the Broadus, Ridge, and Ericson quadrangles for inclusion in his report on the Black Hills rim, and wrote informal reports for the conservation branch on pending cases in southeastern Montana. Mr. Rubey devoted some time to the revision of the report on the Ingomar dome, by K. C. Heald. T. W. Stanton reported on Jurassic fossils from the Big Snowy Mountains for the Absaroka Oil Development Co., and G. H. Girty studied Carboniferous fossils from Montana.

Publications: Press Notice 4655, "The Kevin-Sunburst oil field."

NEBRASKA

G. H. Girty and P. V. Roundy made a short field study of the Permian in Nebraska and began office preparation of the material collected. Mr. Roundy studied outcrop material and well cuttings from the State in connection with his studies in micropaleontology. W. W. Rubey spent a day in Nebraska examining outcrops along Missouri River near Sioux City, Iowa, the type locality of the Dakota sandstone.

NEVADA

A field study of the areal and economic geology of the Hawthorne and Tonopah quadrangles, Nevada, was continued by H. G. Ferguson, assisted by Gordon H. White, and some progress was made in the preparation of a report thereon. T. W. Stanton made preliminary studies of the Jurassic and Triassic invertebrates from these quadrangles and determined the stratigraphic succession of the faunas. Mr. Ferguson completed his report on Camp Gilbert; a paper on the ore deposits of Nevada, for presentation to the Geological Society

of Washington; and a paper on late Tertiary and Pleistocene faulting in western Nevada, for presentation to the Geological Society of America. C. P. Ross examined quicksilver mines in Nevada. C. R. Longwell, assisted by C. E. Erdmann, resumed geologic mapping in the Las Vegas quadrangle. G. R. Mansfield, with L. F. Noble, examined land near Silver Peak on which applications for potash leases had been filed. A report on the geology and ore deposits of the Goodsprings mining district was nearly completed by D. F. Hewett, who also prepared a paper entitled "Progress in the survey of the Ivanpah quadrangle," for the Geological Society of America. F. C. Schrader continued work on his report on the mining districts in the Carson Sink region. Work on the Plöche report was continued by L. G. Westgate and J. L. Gillson. Mr. Gillson wrote a paper on conechalcite from the Bristol mine, Lincoln County, for publication in the American Mineralogist. Carboniferous material from Nevada was studied by G. H. Girty.

NEW MEXICO

J. B. Reeside, jr., and N. H. Darton completed field work on the Permian of southern New Mexico, and Mr. Reeside studied the earlier Mesozoic near Thoreau. Mr. Darton revised and combined his reports on the geology of New Mexico and the "Red Beds" and associated formations of New Mexico and added the results of last season's field work in the Guadalupe region. He prepared a report on the Permian of Arizona and New Mexico for publication in the Bulletin of the American Association of Petroleum Geologists, and in association with J. B. Reeside, jr., a paper on the Guadalupe group for the Geological Society of America. In connection with investigations of the occurrence and nature of potash deposits W. B. Lang watched drilling operations and collected samples from wells in the potash area of southeastern New Mexico. Three press notices were prepared by G. R. Mansfield on the Texas-New Mexico potash area. W. W. Boyer wrote a press notice concerning the Bloomfield Mesa field, San Juan County, and reports on the eastern part of the Sierra Blanca coal field and the La Ventana coal field, for use in classification. A report on the Lake Valley fauna was continued by G. H. Girty. A scientific article on the occurrence of tetradyomite at Hachita is in preparation by M. N. Short. Collections of fossils from New Mexico were identified by F. H. Knowlton, J. B. Reeside, jr., and P. V. Roundy. A. C. Spencer continued work on his Santa Rita report.

Publications: Bulletins 767, 780-B; Press Notices 5134, "The Gallup-Zuni Basin," 4548, "The Bloomfield Mesa oil and gas field, San Juan County," 5077 and 5134, "Potash in Texas and New Mexico," and 6331, "Important potash finds in New Mexico and Texas."

NEW YORK

Progress was made on the Taconic geologic folio, covering portions of the Hoosick and Berlin quadrangles, N. Y., by L. M. Prindle, who also made a study of material collected during a geologic trip through the talc-mining districts of New York. In connection with field examinations in the Bradford oil district, Paul Torrey collected well records and made a study of sand samples and production records in the New York fields. Reconnaissance mapping in a study of the pre-Cambrian crystalline schists in the area north of the Hudson River Highlands was carried on by Mrs. E. B. Knopf in the Milbrook, Copake, Clove, Carmel, and Poughkeepsie quadrangles, and office study of the material collected was begun.

NORTH CAROLINA

A paleontologic paper on additions to the invertebrate fauna of the Upper Cretaceous of the Carolinas was continued by L. W. Stephenson, in connection with which he made a supplementary collection of Cretaceous and Eocene fossils from pits near Rocky Point, Pender County, and collected Miocene fossils near Goldsboro, Wayne County. W. C. Mansfield has in preparation a cooperative report on the Great Lake well No. 2, near Havelock, and a report on the Pliocene and Pleistocene fossils along Neuse River. He identified Miocene, late Tertiary, and Quaternary fossil material from the State. E. W. Berry reported on fossils from North Carolina submitted by Mr. Mansfield.

Publication: Professional Paper 140-C.

OHIO

Frank Leverett made a study of the surface geology of part of southeastern Ohio and the adjacent border of West Virginia, to determine the relation of the silt deposits and sand and gravel to the several stages of glaciation and to drainage modifications. The field expenses were paid by a grant from the Joseph Henry fund by the National Academy of Sciences. A manuscript on Quaternary geology for the Cleveland folio was revised by Mr. Leverett.

OKLAHOMA

Data relative to the oil development on Deer Creek, Okla., were collected by H. W. Hoots for inclusion in the report on Grant County begun by R. S. Knappen. A report on volcanic rocks of the Cretaceous of southwestern Arkansas, southeastern Oklahoma, and northeastern Texas is being prepared by H. D. Miser, L. W. Stephenson, and C. S. Ross; Mr. Miser has completed his portion. Mr. Stephenson is writing a report on the stratigraphy of the Upper Cretaceous formations of Texas, Oklahoma, and Arkansas, and read a paper on this subject at the Dallas meeting of the American Association of Petroleum Geologists, which was subsequently revised for publication in the bulletin of that association. G. H. Girty continued work on his reports on the occurrence of *Martinia* in the Pennsylvanian rocks of Oklahoma, on the Mayes fauna, and on the Moorefield fauna. Well cuttings and outcrop material from Oklahoma were examined by P. V. Roundy in connection with his studies in micropaleontology. H. D. Miser and Miss M. G. Wilmarth prepared a correlation table for a report by C. N. Gould on the geology of Oklahoma. Mr. Roundy, C. H. Dane, P. D. Torrey, and Miss A. M. Farrell were in attendance at the Geological Survey's exhibit at the International Petroleum Exposition and Congress, held at Tulsa October 1-10, 1925, and Mr. Roundy attended the sale of Osage leases at Pawhuska to advise the Office of Indian Affairs regarding adequacy of bids. A revised oil and gas map of Oklahoma was prepared by G. B. Richardson. C. E. Siebenthal continued work on the Wyandotte report.

OREGON

G. R. Mansfield examined diatomite deposits at Terre Bonne, Oreg. W. C. Mansfield prepared a report on fresh-water fossils, probably of Pliocene age, collected by H. T. Stearns from lake beds near Lakeview.

PENNSYLVANIA

Paul Torrey began field work in the Bradford district, Pennsylvania, which included the study of factors influencing water and oil movement through the sand, collection of production data of flood wells, traverses, collection of fossils and water samples, examination of sand samples from wells, study of acre yields and composite decline curve of natural production, measurement of samples, and structural mapping. He also made observations of the erosional effects of an ice gorge. W. C. Mendenhall, Charles Butts, W. T. Thom, Jr., and P. G. Nutting visited Bradford during the year for conferences with the operators and Mr. Torrey on field problems in the district. Mr. Butts did field work in the Bradford quadrangle and reported on fossil collections from this quadrangle for Mr. Torrey. A press notice on getting more oil from oil-field sands, based partly on the work of P. G. Nutting on Bradford sands, was written by David White. Field work in the Tyrone quadrangle was completed by Mr. Butts, and office work on the final map and text was continued. Revision of field mapping in the Bellefonte quadrangle was also completed by Mr. Butts. G. H. Girty completed his report on the Pocono fauna of the Broadtop coal field, prepared a report on Devonian-Carboniferous fossil collections, and reported on Carboniferous fossils from the State. Mrs. E. B. Knopf revised the chapter on physiography in the manuscript on the geology of the Quarryville and McCallis Ferry quadrangles. P. V. Roundy studied ostracodes from Pennsylvania.

A geologic map of Pennsylvania for eventual publication by the State survey is being compiled under the direction of G. W. Stose and is in large part completed. Field work in the Middletown, Lancaster, and York quadrangles was carried on by A. I. Jonas and Mr. Stose in preparation of a folio, and

field work in the New Cumberland quadrangle was done by Mr. Stose to bring results up to date for publication by the State. Mr. Stose, as joint author with Florence Bascom, revised the Fairfield-Gettysburg folio and completed the Coatesville-West Chester folio. He also wrote a geologic report on Adams County for publication by the State survey. Work on a report on the coal and oil resources of the New Kensington quadrangle was continued by G. B. Richardson, who also prepared data for the Pennsylvania Geological Survey on coal in the Butler quadrangle and revised the text and maps of the Somerset-Windber folio. Edwin Kirk and R. D. Mesler reported on paleontologic material from Pennsylvania.

Publication: Press Notice 2156, "Experiments in getting more oil from oil-field sands."

SOUTH CAROLINA

C. W. Cooke continued work on his report on the geology of the Coastal Plain of South Carolina, which included the preparation of a geologic map of the State, and studied cuttings from deep wells in the State. He was assisted in studies of the Miocene fauna by W. C. Mansfield.

SOUTH DAKOTA

T. W. Stanton examined Cretaceous fossils from a diamond-drill core from northern Ziebach County, S. Dak., for the State geologist. W. W. Rubey examined the oil possibilities of a region near Edgemont for the conservation branch, collected fossil plants near Hot Springs, and visited the bentonite quarries near Ardmore and Belle Fourche. F. H. Knowlton reported on the distribution of supposed Dakota flora in the Black Hills region for Mr. Rubey.

TENNESSEE

H. D. Miser spent a little time reviewing the geology of the Waynesboro quadrangle, Tenn., an important iron-ore area, in cooperation with the Tennessee Geological Survey. E. W. Berry continued work on a paper on the Wilcox flora of western Tennessee. E. F. Burchard completed a report on the brown iron ores of west-middle Tennessee. G. H. Girty studied Carboniferous fossils from the State, and R. D. Mesler prepared Paleozoic fossils.

TEXAS

W. B. Lang continued to visit wells, interview drillers, obtain samples of potash, and study stratigraphic conditions in western Texas. Four press notices on the Texas potash area were prepared by G. R. Mansfield. L. W. Stephenson continued his field study of the Gulf series of the Cretaceous formations in northeastern Texas. He was accompanied for several days by H. D. Miser and C. H. Dane, the object of whose work was to cooperate in correlating the Cretaceous formations in that area with corresponding formations in Arkansas and Oklahoma. Mr. Stephenson is preparing a report on the stratigraphy of the Upper Cretaceous formations of Texas, Oklahoma, and Arkansas and read a paper on this subject at the Dallas meeting of the American Association of Petroleum Geologists, which was subsequently revised for publication in the Bulletin of that association. He also made a reconnaissance investigation of lignite deposits in the northeastern part of Morris County. N. H. Darton and J. B. Reeside, jr., completed field work on the Permian of southern New Mexico and northwestern Texas and prepared a paper on the Guadalupe group of this region for publication in the Bulletin of the Geological Society of America.

Messrs. Stephenson and Darton are gathering and compiling data for a revised geologic map of Texas in cooperation with the State Bureau of Economic Geology and Technology, Mr. Stephenson working in the Coastal Plain region and Mr. Darton in the western part of the State. In this connection Mr. Darton was engaged in reconnaissance mapping of a part of northwestern Texas and revision of mapping in Wheeler, Armstrong, Donley, Collingsworth, Childress, Cottle, Motley, and Hull Counties, and held conferences with the State geologist at Austin. An investigation of the extent and character of certain structural features in the Amarillo field, Potter County, was made by W. W. Rubey for the Bureau of Mines. Field work on the Midway formation of

Texas, in cooperation with the Bureau of Economic Geology and Technology, was continued by Julia Gardner, who also studied well cores from the Midway formation in the laboratory of the State bureau. Office work on a map of the region was begun. M. I. Goldman continued study and laboratory work relative to salt-dome cap rocks. H. D. Miser, C. S. Ross, and L. W. Stephenson continued the writing of a report on the volcanic rocks of the Cretaceous of southwestern Arkansas, southeastern Oklahoma, and northeastern Texas. An oil and gas map of the State was prepared by G. B. Richardson. T. W. Stanton reported on Comanche invertebrates and Cretaceous fossils from Texas. P. V. Roundy continued the examination of well cuttings from the State in connection with his studies in micropaleontology. Office work on reports on the Cisco fauna and on the faunas of Mississippian formations of San Saba County was continued by G. H. Girty, who examined Texas Carboniferous fossil material. Messrs. Roundy and Girty continued work on the report on the Bend fauna of Texas. W. C. Mansfield prepared a report on Eocene fossil material from the vicinity of Bastrop. F. H. Knowlton reported on supposed Cretaceous fossils for W. B. Lang.

Publications: Bulletin 780-B; Professional Paper 146; Map showing oil and gas fields of the State of Texas; Press Notices 5077 and 5184, "Potash in Texas and New Mexico," 6331, "Important potash finds in New Mexico and Texas," and 7714, "Fifteen more potash wells in Texas."

UTAH

James Gilluly, assisted by E. T. McKnight and S. S. Nye, completed areal, stratigraphic, and structural studies in the San Rafael Swell and a report on the geology and oil and gas prospects of part of the Swell. Mr. Gilluly and J. B. Reeside, jr., wrote a report on the sedimentary rocks of the San Rafael Swell and some adjacent areas in eastern Utah and also a paper on Jurassic rocks of eastern Utah, which was presented at the meeting of the Geological Society of America. A report was written by Mr. Gilluly on parts of T. 22 S., R. 8 E., Emery County, Utah, for the conservation branch. Messrs. Reeside and Gilluly studied the Wingate-Morrison sequence from the San Rafael Swell to a point near Moab and visited the Cretaceous section on the west flank of the Henry Mountains. Field and office study of the Gold Hill mining district was begun by T. B. Nolan. Mr. Nolan continued his work in the Salduro Marsh, in cooperation with the General Land Office and the Bureau of Mines. G. R. Mansfield spent one day with Mr. Nolan in this area. Mr. Nolan wrote a paper on potash brines underlying the Great Salt Lake Desert, and also a report on this same subject for the conservation branch. W. H. Bradley, assisted by R. D. Ohrenschaal, continued field study of the stratigraphy of the Green River formation in eastern Utah. He is writing papers on the stratigraphy of the Green River formation in Colorado and Utah and on the alga reefs and oolites of the Green River formation.

E. M. Spieker and D. J. Fisher continued general stratigraphic work and detailed coal work in the Wasatch Plateau and Book Cliffs region. Mr. Spieker made stratigraphic and structure studies and did geologic mapping on the west flank of the Wasatch Plateau, chiefly in Manti, Sixmile, and Twelvemile Canyons and the intervening country, and, together with Mr. Reeside, studied the Mesozoic and Tertiary formations along the Book Cliffs from Woodside, Utah, to Grand Junction, Colo. He wrote a paper entitled "Post-Cretaceous orogeny in central Utah," covering the west side of the Wasatch Plateau, for presentation before the Geological Society of America, and completed the revision of his paper on the Wasatch Plateau coal field. He prepared for the conservation branch reports on coal near Crescent, Grand County, and on other small areas in the State. Mr. Fisher made progress on his report on the Book Cliffs coal field. Mr. Reeside wrote a memorandum on correlation of the Cretaceous of southern Utah for R. C. Moore and worked on a joint paper by Mr. Spieker and himself on the Upper Cretaceous shore line in Utah for presentation to the Geological Society of America. A report entitled "A section of the Kalbab limestone in Buckskin Gulch, Utah," was completed and submitted for publication by L. F. Noble. Field investigation as a basis for a report on the economic geology of the Fairfield and Stockton quadrangles was begun by Sidney Paige and continued by James Gilluly. W. C. Alden studied the glacial geology and physiography of Bear River Valley and of the Wasatch

Mountains, near Salt Lake City, and studied the region bordering the north front of the Uinta Mountains from Provo, Utah, east to Green River and Rock Springs, Wyo.

W. T. Lee, assisted by Paul Torrey, W. W. Boyer, and George Hansen, was engaged in stratigraphic work connected with coal and oil land classification in eastern Utah and western Colorado. Mr. Lee prepared a report on the continuity of formations in western Colorado and eastern Utah, which was transmitted to the open files and the conservation branch. Mr. Boyer wrote a report on coal in the Dakota (?) formation of southwestern Colorado and southeastern Utah and, for the conservation branch, a report on the stratigraphy and structure of Lisbon and East Moab Valleys, Grand and San Juan Counties. W. T. Thom, jr., and Messrs. Lee, Boyer, and Gilluly prepared a press notice on oil possibilities of southwestern Colorado and southeastern Utah. In the spring of 1926 further field study of the oil and gas possibilities of southeastern Utah was taken up by field parties in charge of A. A. Baker and E. T. McKnight, working under the general direction of C. E. Dobbin. Messrs. Gilluly and Reeside were associated with Mr. Dobbin at the beginning of the work, and S. S. Nye, N. F. Stull, G. H. Hansen, Charles Brewer, jr., and J. L. Anderson assisted in it. F. C. Calkins continued work on the report on the general geology of the Cottonwood district. B. S. Butler, assisted part of the time by Mr. Gilluly, studied late developments in this district. Edwin Kirk studied the Paleozoic formations with Messrs. Butler and Gilluly. Messrs. Reeside and Kirk, G. H. Girty, R. D. Mesler, and F. H. Knowlton reported on fossil collections from the State.

Publication: Press Notice 6064, "Possibility of finding oil in southeastern Utah and southwestern Colorado."

VERMONT

Arthur Keith studied the Taconic stratigraphy and structure of northwestern Vermont. L. M. Prindle made some progress on the Taconic folio and studied material collected by him during a geologic trip through the talc-mining districts of Vermont.

VIRGINIA

W. C. Mansfield prepared for outside publication a paper entitled "Note on the occurrence of the Choptank formation in the Nomin Cliffs, Virginia." G. H. Girty examined Carboniferous fossils from the State. E. W. Berry reported on fossils from Virginia for W. C. Mansfield. C. P. Ross made an investigation and a report on the available ground-water supplies of Arlington County, at the request of the Arlington County Water Supply Commission. C. K. Wentworth, accompanied by M. R. Campbell a part of the time, examined terraces and gravel deposits of Pliocene and Pleistocene age in Virginia. W. T. Lee, at the request of the city of Clifton Forge, made a brief examination in order to advise the city officials regarding the site for a new dam which the city proposes to build. He prepared a report on this examination. An article on the Natural Tunnel of Virginia was written by G. W. Stose for publication by the Southern Railways in an advertising pamphlet and by the Virginia Geological Survey.

Publication: Press Notice 4479, "Water supply for Arlington County."

WASHINGTON

J. T. Pardee wrote a press notice on manganese in the Olympic Mountains, Wash., and a report on manganese-bearing rocks near Lake Crescent and Humpulips, the field examination for which was made in August, 1925. Mr. Pardee and C. S. Ross contributed material for a paper by Kirk Bryan on the "Palouse soil" problem, with an account of elephant remains in wind-borne soil on the Columbia Plateau. G. R. Mansfield examined magnesite deposits at Chewelah. F. H. Knowlton continued work on a description of the flora of the Puget formation and studied the plant-bearing rocks of the Latah formation in the vicinity of Spokane.

Publication: Professional 140-A.

WEST VIRGINIA

Edwin Kirk prepared a report on Ordovician, Silurian, and Upper Devonian fossils submitted by D. B. Reger, of the West Virginia Geological Survey, and, at G. H. Girty's request, a description of a new species of crinoid from the Mississippian of West Virginia. A study of the surface geology of the portion of West Virginia adjacent to southeastern Ohio was made by Frank Leverett to determine the relation of the silt deposits and sand and gravel to the several stages of glaciation which affected the district to the north; the field expenses for this study were paid by the National Academy of Sciences from the Joseph Henry fund.

WISCONSIN

G. H. Girty and P. V. Roundy collected pre-Carboniferous fossils in Wisconsin.

WYOMING

T. S. Lovering and E. F. Burchard examined the Seminoe iron deposits, Carbon County, Wyo., and Mr. Lovering wrote a report on them. W. C. Alden continued his studies of physiography and glacial geology in Wyoming, embracing parts of Carbon and Natrona Counties, the Salt Range, the Tetou Mountains, Jackson Hole, the Gros Ventre Mountains (slide of 1925), Hoback Canyon, the Green River valley and Wyoming Range, and the region of Kemmerer and Evanston. He continued work on his report on the physiography and glacial geology of Wyoming and wrote for unofficial publication a paper on the Gros Ventre landslide of June, 1925. C. D. Avery's oil scouting took him to the Garland, Byron, Lovell, Oregon Basin, Hidden Dome, and Thermopolis districts and to Casper, Cheyenne, Rawlins, and Cody. The report by C. H. Wegemann, C. E. Dobbin, and R. W. Howell on the Pumpkin Buttes coal field was revised and transmitted for publication.

J. B. Reeside, jr., and W. T. Thom, jr., made a reconnaissance study of the Piney formation between Big Horn and Parkman. Mr. Reeside wrote a report on cephalopods from the lower part of the Cody shale of Oregon Basin; examined Cretaceous fossils collected in northern Wyoming by E. Binney, jr., in the Rock River region by Mr. Dobbin, and in the Parkman region by Mr. Thom and himself; and arranged and examined lists of Pierre fossils from the western Black Hills. T. W. Stanton reported on core samples from a well at Lingle and examined cuttings from a well in the Labarge field. Edwin Kirk prepared paleontologic material from the Ordovician of Wyoming. G. H. Girty examined Carboniferous fossils from the State. Mr. Thom began work on a structure contour map of Wyoming. A. A. Baker wrote an informal report on oil possibilities of the Steele Creek anticline, in T. 46 N., R. 82 W., for the conservation branch. C. E. Dobbin, assisted by H. W. Hoots, C. H. Dane, C. D. Avery, and P. D. Torrey, reexamined the Hanna Basin coal field, Tps. 12 to 16 N., Rs. 88 to 92 W., Carbon County, and mapped the Belle and Buck Springs domes, Tps. 22 and 23 N., Rs. 88 and 89 W., and the structure in Tps. 18 and 19 N., R. 87 W.; made a reconnaissance structural examination of the west side of the Sierra Madre southward to the Colorado boundary; and checked and brought up to date information on the Rock Creek oil field previously collected by Hancock and Dobbin, extending the limits of the area mapped to cover the Cooper Cove and Dutton Creek anticlines and to connect with the mapping in the Hanna and Carbon Basins. Reports covering the examinations in the Hanna Basin, Bell Springs district, and Rock Creek district were prepared and transmitted to the conservation branch and for publication, and a report on the area west of the Sierra Madre was submitted to the conservation branch. G. B. Richardson revised the oil and gas map of Wyoming. W. W. Rubey did further field work in Weston, Crook, and Campbell Counties and continued to write his reports on the Black Hills rim. He prepared a map and memorandum for the conservation branch on an oil-lease appeal near Newcastle and a memorandum on irrigation possibilities near Moorcroft. A. A. Baker checked the mapping of the Steele Creek anticline in T. 46 N., R. 82 W., and submitted a report regarding it to the conservation branch. Mr. Thom prepared for the conservation branch two blue prints of a structure map of the Bolton Creek dome and adjacent structural features. M. R. Campbell and Mr. Reeside, assisted by Waldo S. Glock and K. K. Landes, studied part of the

Cretaceous section in the south end of the Little Snake River coal field for the purpose of correlating the coal beds with those of the Yampa field in Colorado. Publications: Professional Papers 140-D and 145; Bulletins 780-C and 781-B.

OTHER WORK

A field and office study of the causes of earthquakes affecting New England was carried on by Arthur Keith.

C. S. Ross made an investigation of the copper deposits of the southern Appalachian States and began a report on these deposits.

F. H. Knowlton reported on Miocene plants from British Columbia for the Secretary of the Smithsonian Institution, and G. H. Girty studied Carboniferous fossils from British Columbia.

Edwin Kirk prepared a paper on a new Devonian pelecypod genus from China.

T. W. Stanton examined Cretaceous invertebrates from Cuba.

G. H. Girty worked on a report on a Carboniferous fauna in Mexico.

T. W. Stanton identified Cretaceous invertebrates from Mongolia for Barnum Brown.

J. B. Reeside, jr., examined Cretaceous fossils from Venezuela submitted by J. T. Duce for the Texas Co.

E. F. Burchard examined iron and manganese ore deposits in the State of Minas Geraes, Brazil.

W. P. Woodring continued work on his report on Miocene mollusks from Bowden, Jamaica, in cooperation with the Carnegie Institution of Washington; assembled for the National Research Council data on tectonic history and submarine topography of the Caribbean region; and determined a collection of Tertiary fossils from Porto Rico submitted by the Isabela Irrigation Service.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH

The personnel of the division of chemical and physical research, consisting of 7 chemists, 2 physicists, 1 laboratory aid, 1 clerk, and 1 laborer, as well as the organization, remained unchanged during the year. George Steiger was in charge of the work in chemistry and acted in charge of the division when necessary, and C. E. Van Orstrand was in charge of the work in physics.

WORK IN CHEMISTRY

The work in chemistry comprised the partial and complete analyses of rocks and other geologic products, the identification and analysis of minerals, the study of geochemical problems, and researches in mineralogic chemistry. During the year 6,274 specimens were examined, of which 2,621 were analyzed or mineralogically examined for the official work of the Geological Survey and 3,653 were identified for citizens. On June 30, 1926, there were awaiting attention 650 samples for analysis and 35 for identification.

W. T. Schaller's continued study of the natural history of pegmatites, in both laboratory and field (Maine, Massachusetts, Connecticut, Pennsylvania, Maryland, Virginia, and North Carolina), has amply verified the conclusion reached by him last year as a result of studies of pegmatites from California, that many of the pegmatites, as now seen, are not the original magmatic rock but are the result of later replacement processes. In consequence it seems probable that many ideas relating to the petrogenesis of igneous rocks in general may need considerable revision. A preliminary paper on this subject, entitled "The genesis of lithium pegmatites," was published, progress was made on the revision of the report on the gem tourmaline field of southern California, and papers on replacements in pegmatites, the origin of graphic granite, and the petrogenic meaning of eutectic-like structure in rocks are in preparation. Mr. Schaller lectured on the last subjects before the mineralogical clubs of Philadelphia, New York, and New Haven, attended the annual meeting of the Geological Society of America at New Haven, was elected president of

the Mineralogical Society of America, and received the first prize offered by the Geological Society of Washington for excellence in presentation of paper. Papers on purple muscovite from New Mexico and uranium minerals from Lusk, Wyo., were published in outside journals, and he continued studies on the various autunites and on the minerals in the potash field of Texas, identifying celestite (strontium sulphate).

Bulletin 778, "Chemistry of deposition of native copper from ascending solutions," by R. C. Wells, was published during the year, also a short paper on "What is an element?" and a table on the age of minerals for the "International critical tables of constants." This table gives the ages of minerals found by combining analytical data with the genetic relationships among the radioactive elements and their products arrived at by physicists. The ages thus found run up into hundreds of millions of years and allow the time for the several genetic epochs that some geologists have felt necessary to assume on other grounds. Mr. Wells also wrote a paper on the salinity of the water of Chesapeake Bay and conducted experiments on the reduction of sulphates, incidental to a study of the ashes from petroleum cokes.

Experiments with various methods for determining extremely small quantities of platinum were made by George Steiger and E. T. Erickson. The coatings on sand grains were studied chemically by Mr. Steiger with relation to P. G. Nutting's investigations of the migration of oil, and their physical and chemical properties were studied by R. C. Wells. Mr. Steiger prepared a report for the committee on sedimentation, National Research Council, on the work done in chemistry during the year which related to the problem of sedimentation, and in joint authorship with E. S. Larsen wrote a paper on the dehydration of alunogen, nontronite, and griffithite. He also made a series of experiments on the permeability of granite and other rocks.

E. T. Erickson continued a study, including laboratory experiments, on the structural organic chemistry of plant and animal remains and their decomposition products in relation to the formation of natural hydrocarbons. Mr. Erickson also studied the chemistry of the colored material of a paraffin-base petroleum and made experiments on the precipitation of copper by organic agencies.

After studies, including laboratory experiments, E. P. Henderson wrote three papers—"Polycrase from Brazil," in joint authorship with Frank L. Hess; "Topaz and associated minerals from Einstein silver mine," with C. S. Ross; and "Purple muscovite from New Mexico," with W. T. Schaller. Mr. Henderson also practically completed laboratory work which will be the basis of two papers on tetradymite from New Mexico and on triplite from the Black Hills and made laboratory experiments on the separation of columbium from tantalum.

J. G. Fairchild prepared artificial pyromorphite and autunite. In the autunite mineral the base was controlled at will by varying the composition of the brine used in its synthesis.

The laboratory tested 1,800 salts for potash, and those showing more than 1.5 per cent K_2O (642) were also quantitatively assayed. The salts came from 41 different wells distributed over 15 counties in western Texas and southeastern New Mexico. Each of the wells produced salts containing more or less potash, but the most promising were in Reagan, Crane, and Upton Counties, Tex., and Lea County, N. Mex. The Texon well No. 3, Reagan County, showed two rich zones at depths of 1,450 to 1,550 feet and 1,255 to 1,310 feet, and the richest salts in these zones contained 10.22 and 11.25 per cent of K_2O , respectively. The Campbell State well, the Texon well No. 2, and the California well, all in Reagan County, yielded 23 salt samples each containing more than 3 per cent K_2O , the highest content being 13.60 per cent. Five wells in Upton County yielded 18 salt samples each containing more than 3 per cent K_2O ; the richest of these was taken from the Mary Baker well No. 1 and assayed 12.72 per cent. Other wells producing rich samples of potash salts were the Cordona and Cowden wells of the Cordona Oil & Potash Co., and the Cowden well No. 1 of the Texas Development Co., all in Crane County; the Sherbino well, in Pecos County; Hill Bros. well No. 1, Midland County; Hutchings well No. 1, Ward County; and the Stevens well, in New Mexico. This group of wells produced 30 salt samples each containing more than 3 per cent of K_2O , and the richest sample contained 9.60 per cent.

The result of the year's work confirms the conclusion previously drawn that rich potash salts may be expected at relatively shallow depths, the salts analyzed during the year with the best showings having been obtained 800 to 1,600 feet below the surface. The figures given all refer to the percentages of K_2O in the sample as taken from the well and not in the soluble salt, which would be considerably higher. R. K. Bailey has improved the method of analysis, especially the qualitative test. Mr. Bailey also identified carnallite from the Crescent Eagle well, near Thompson, Utah; and sylvite from the McNutt well No. 1, Carlsbad, N. Mex.; and the first piece of white polyhalite found in the United States, which came from the Virginia-Texas well, Upton County, Tex.

WORK IN PHYSICS

The use of geophysical methods of research in pure and applied geology is an important phase of scientific development to which the geologist is gradually turning for assistance in the solution of numerous problems. Two distinct contributions in this field were made from the physical laboratory during the year—one by C. E. Van Orstrand on deep earth temperatures and one by P. G. Nutting on petroleum recovery.

The results thus far obtained in the general investigation of deep earth temperatures show that the temperatures in individual wells often reflect correctly the existence of marked subsurface conditions, and comparison of the results obtained from a group of wells in the same field shows that the highest temperatures are to be expected on the structural crests. These results are obviously of very considerable practical and theoretical significance. In order to determine the general applicability of the tentative conclusion that the highest temperatures are to be found on the structural crests, the investigation is being extended to as many fields as possible, and last summer preliminary observations were made at Fort Collins, Colo., Long Beach, Calif., and El Dorado, Ark. Incidentally a few observations were made in the Moffat Tunnel, East Portal, Colo.; and tests were made in a well at Longmont, Colo., which had reached a depth of 7,300 feet. A temperature of $212^{\circ} F.$, the boiling point of water at sea level, was found in this well at a depth of about 6,600 feet.

In the field of petroleum recovery Mr. Nutting has devoted his time largely to investigating the movements of fluids through porous solids to determine the essential factors upon which that movement depends. This work has centered about the motion of petroleum, water, and water solutions through oil sands and the effects of pressure, porosity, adsorption, surface tension, and similar factors upon that movement.

The application of sodium carbonate solutions to the driving of petroleum from oil sands, described in a report released July 2, 1925, was followed by several conferences with producers in the Bradford field, Pa., who entered whole-heartedly into the development of the field technique of its use. Soda was introduced into many wells, and it is thought that some indications of success of the process can already be noted. However, as the ordinary water-driving period is 30 months, several years will be required to test out the process and develop the best methods of applying it in different oil fields. Laboratory research has been devoted to the details and limitations of the process, the amount of soda used up per foot of drive, the effects of rate of drive, pore space, and foreign salts in connate waters, of coatings of silicates, oxides, and hydrocarbon compounds on the sand grains, and the filtering action of some sands on some oils. Findings have been reported in a number of scientific papers. The chemical problems involved have centered about the interrelations of oil, water, and silica; the physical problems about the relative motions of fluids and solids. Considerable time has been given also to conferences with and work for geologists interested in the field, covering folding, faulting, shearing rupture, exfoliation, and related problems. Volcanologists and seismologists are also interested in laboratory research in this field.

E. B. Hill, of the topographic branch, assisted in the reduction of observations of deep earth temperatures from April 8 to the end of the fiscal year.

ALASKAN BRANCH

PERSONNEL AND EXPENDITURES

On July 1, 1925, the personnel of the Alaskan branch consisted of 1 chief Alaskan geologist, 3 geologists, 3 associate geologists, 1 assistant geologist, 3 topographic engineers, 1 supervising mining engineer, 1 coal-mining assistant, 1 metal-mining assistant, 1 draftsman, and 3 clerks; on June 30, 1926, it consisted of 1 chief Alaskan geologist, 3 geologists, 4 topographic engineers, 1 supervising mining engineer, 1 mining engineer, 1 associate mining engineer, 1 coal-mining assistant, 1 metal-mining assistant, 1 draftsman, and 3 clerks. One additional associate mining engineer was employed from July 15, 1925, to January 15, 1926, and one clerk from October 5, 1925, to June 15, 1926. The increase in the total personnel of the Alaskan branch over that of preceding years resulted from the transfer to the Geological Survey of activities formerly conducted by the Bureau of Mines in Alaska. This change added four persons to the Alaskan branch on July 1, 1925, and two others on June 30, 1926. It may be noted that the number of geologists now connected with the Alaskan branch is less than at any other time since the organization of this work in 1903.

The season for the field work of the Geological Survey in Alaska commonly extends from May to October and thus overlaps two fiscal years, but as the appropriations are made available for immediate use field work may be done at the end of a fiscal year on two appropriations simultaneously. The following statements, therefore, relate principally to the work of the field season of 1925, as just defined, and to the beginning of the field season of 1926.

The funds available in part for the fiscal year 1926 included the appropriations of \$72,000, carried in the Interior Department bill, available March 3, 1925, and \$50,000, carried in the Interior Department bill for the fiscal year 1927, available May 10, 1926. In addition to these sums, appropriated directly for expenditure by the Geological Survey, \$22,000 was transferred to the Geological Survey from the appropriation of \$33,000 for the Alaska work of the Bureau of Mines, contained in the Interior Department bill for the fiscal year 1926, and \$12,300 remained from funds amounting to \$75,000, which were made available to the Geological Survey by transfer from the Navy Department for the continuation of the investigation of Naval Petroleum Reserve No. 4, in northern Alaska. Three of these appropriations were legally available and were drawn on for expenses incurred in the fiscal year 1925; all four were available and used in part in the fiscal year 1926; and the unexpended greater part of the appropriation for the fiscal year 1927 is still available for expenditure during the year.

The expenditures from all these funds have been accounted for under the methods and procedure laid down by law or by the regulations of the Treasury Department, but these methods do not lend themselves to showing the costs during a single fiscal year or concerning individual projects. The labor and expense of determining the precise expenditures for the different jobs by years would far exceed the value of the resulting analysis, and therefore these expenditures have not been accurately computed. The following state-

ments give only in round figures the principal uses to which the funds were put during the fiscal year 1926. The amount expended in starting off the parties in advance of the beginning of the fiscal year in the field season of 1925 practically offset the amount used to start the parties at the end of the fiscal year 1926 to begin the work of the field season of 1926. Thus, except for the work financed by the Navy Department and the supervision of mineral leasing financed by a transfer from the Bureau of Mines, which will be analyzed separately, the funds used for the fiscal year 1926 were \$72,000, expended approximately as indicated below:

Expenditures from funds directly appropriated for Geological Survey Alaska work

Branch administration.....	\$5,500
Other technical salaries.....	21,450
Branch clerical and drafting salaries.....	5,900
Services rendered by other Survey units, including editing, duplicating-machine service, accounting, and other expenses.....	5,800
Office expenses, stationery, telegrams, photography, and other expenses.....	2,300
Field expenses.....	30,600
Airplane mapping by Navy Department (cooperative).....	450
	<hr/> 72,000

The items in the table "Other technical salaries," "Field expenses," and "Airplane mapping" and \$1,500 of the item for clerical salaries have been allotted for the different kinds of surveys and investigations in progress during the fiscal year 1926, as follows:

General investigations.....	\$1,875
Geologic surveys.....	33,800
Topographic surveys.....	16,425
Statistics of mineral production.....	1,900
	<hr/> 54,000

In this table it is not possible to determine accurately the distribution of expenses to topographic and geologic surveys where combined topographic and geologic parties are concerned, and such expenses are divided equally, although the cost of the topographic surveys is thereby underestimated.

Approximate cost and distribution of work by geographic divisions for the fiscal year 1926

General investigations.....	\$1,875
Southeastern Alaska.....	6,950
Prince William Sound.....	6,600
Matanuska region.....	1,075
Southwestern Alaska.....	6,525
Skwentna-Kuskokwim region.....	5,675
McKinley region.....	4,100
Upper Yukon and Sheenjek regions.....	10,525
Northern Alaska.....	8,175
Statistics of mineral production (including \$1,500 for clerical salaries).....	1,900
	<hr/> 54,000

The balance of \$12,300 remaining from the funds made available to the Geological Survey by transfer from the Navy Department for investigation of Naval Petroleum Reserve No. 4 was expended as shown in the following table:

Allocation of funds for surveys in Naval Petroleum Reserve No. 4, northern Alaska

Administration-----	\$1,375
Technical salaries-----	5,750
Clerical and drafting salaries-----	1,700
Field expenses-----	3,475

12,300

The following table shows the progress that has been made in topographic and geologic surveys in Alaska since 1898, including the field season of 1925. Three types of surveys of different scales and of correspondingly different degrees of accuracy have been made. Wherever an overlapping of surveys of different kinds has taken place only the area mapped on the largest scale is tabulated.

Areas surveyed by Geological Survey in Alaska, 1898-1926, in square miles

Fiscal year	Areas covered by geologic surveys			Areas covered by topographic surveys		
	Exploratory (scale 1:500,000, 1:625,000, or 1:1,000,000)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500)	Exploratory (scale 1:500,000, 1:625,000, or 1:1,000,000)	Reconnaissance (scale 1:250,000; 200-foot contours)	Detailed (scale 1:62,500; 25, 50, or 100 foot contours)
1898-1925-----	75,500	140,720	5,847	55,980	180,650	4,066
1926-----		13,785	130		9,500	
	75,500	154,505	5,977	55,980	190,150	4,066
Percentage of total area of Alaska--	40.2			42.6		

WORK OF THE YEAR

Under the heading "General investigations" in the preceding tables are included studies which relate to the broader problems of Alaskan geologic history as well as to investigations in specific fields. Among them are paleontologic studies which, through the courtesy of the geologic branch, were carried on mainly by the specialists of that branch. These studies are of the greatest importance in solving the problems connected with deposits of coal and petroleum, as well as in the study of geologic history. They include the determination of Mesozoic invertebrate fossils from the upper Yukon and the Alaska Peninsula by T. W. Stanton; of Carboniferous fossils from the upper Yukon and southeastern Alaska by G. H. Girty; of Ordovician, Silurian, and Devonian invertebrates from the upper Yukon and southeastern Alaska by Edwin Kirk; of fossil plants from the Alaska Peninsula by F. H. Knowlton; of Triassic and Cretaceous invertebrates from northern Alaska by J. B. Reeside, jr.; and of Middle Cambrian invertebrates from the upper Yukon by C. E. Resser. Analyses of potash waters were made by the water-resources branch and analyses of minerals by the chemical laboratory. Additional work was done by James McCormick on the revision of the "Geographic dictionary of Alaska," which was published in 1906 but has been out of stock for many years. This bulletin is of great value as a reference list of Alaskan geographic names.

The publications of the year consist of papers on parts of Alaska Peninsula (Bulletin 773-D) and the Chandalar district (Bulletin 773-E); the consolidated report on the progress of investigations in Alaska in 1923 (Bulletin 773); the administrative report and a report on the mineral industry of Alaska in 1924 (Bulletin 783-A); and a comprehensive summary of the Mesozoic stratigraphy of Alaska (Bulletin 776). (See p. 9.)

In the Washington office Miss Lucy M. Graves, chief clerk of the branch, acted as chief of the branch during the absence of Philip S. Smith in the field in 1925. S. R. Capps acted as branch chief from February 8 to May 21, 1926, and F. H. Moffit from May 22 to the end of the fiscal year. Miss Erma C. Nichols, statistical clerk, devoted a considerable part of her time to the collection and coordination of mineral statistics. Mrs. Marion E. Maclean was engaged in general clerical work from the time of her connection with the branch, October 5, 1925, until June 15, 1926. On June 16, 1926, she was temporarily transferred to the topographic branch. John B. Torbert, scientific illustrator, was engaged throughout the year in the preparation and drafting of topographic maps and illustrations.

FIELD SEASON OF 1925

The field work of the Alaskan branch in the fiscal year 1926 includes parts of two field seasons, 1925 and 1926. In 1925 eight field parties were at work in Alaska, comprising five geologic parties, one topographic party, and two combined topographic and geologic parties, with which were connected seven geologists and three topographers. In addition the chief Alaskan geologist inspected different field parties and carried on administrative work in Alaska.

Philip S. Smith, chief Alaskan geologist, was engaged in office work in Washington till July 12, 1925, when he left for Alaska. He spent about one week in visiting the field party in charge of A. F. Buddington at Hyder, in southeastern Alaska, and an equal time with the party under Fred H. Moffit on Prince William Sound. Most of his field season, however, was spent in Juneau, Anchorage, and Fairbanks, and in the Matanuska and Nenana coal fields in consultation with Messrs. Stewart and Corey concerning plans for carrying on the work transferred from the Bureau of Mines and in studying the mining situation.

A. F. Buddington made a reconnaissance of the west coast of Dall Island and spent the later part of the season of 1925 in detailed geologic surveys in the Hyder district at the head of Portland Canal, adjacent to one of the active Canadian silver-lead camps. A description of this work has been prepared for publication.

R. K. Lynt carried on detailed topographic surveys in Wrangell Narrows near Petersburg, in southeastern Alaska, in cooperation with the General Land Office.

Fred H. Moffit continued the investigation of the copper and other metaliferous deposits of Prince William Sound, one of the important copper-producing districts of Alaska which has also been a producer of gold and gives promise of further development. At the end of the field season on Prince William Sound he visited Chitina Valley to collect information on the progress of mining in that district.

K. K. Landes made a reconnaissance geologic survey of an area of about 335 square miles on the south side of Matanuska River, between that stream and Knik River.

R. H. Sargent, topographer, and R. S. Knappen, geologist, made topographic and geologic surveys of an area of 3,000 square miles, extending the full width of the Alaska Peninsula from Aniakchak Crater to a point 25 miles west of the Chignik Lakes. These surveys, whose primary object was to assist in developing the oil resources of the region, completed a series planned to cover the prospective oil-bearing portion of the peninsula.

S. R. Capps carried on reconnaissance geologic surveys on the northwest side of the Alaska Range in the Toklat-Tonzona district of the Mount McKinley region. An area of 2,000 square miles was covered. This survey was in part a resurvey on a larger scale of an area covered by an exploratory survey by A. H. Brooks and D. L. Reaburn in 1902.

J. B. Mertle, jr., made geologic surveys along Yukon River between the international boundary and Circle and at the end of the season spent a week in the vicinity of Fairbanks collecting statistics on mineral production. The surveys on the Yukon covered 1,500 square miles and were in part a resurvey of an area covered by exploratory surveys.

Gerald FitzGerald, topographer, and W. R. Smith, geologist, left Washington in February, 1925, to extend the surveys already made in Naval Petroleum Reserve No. 4, in northern Alaska. They traveled by dog team from Nenana down the Yukon to Norton Sound and thence north to Kotzebue, where they

obtained supplies for the summer. They then completed their winter trip up the Noatak and across the divide to the Arctic slope, arriving before the spring break-up. Their field work began late in April and resulted in exploratory and reconnaissance surveys covering 6,500 square miles, principally in the headwater region of Colville River and some of the northern tributaries of the Noatak.

FIELD SEASON OF 1926

In 1926 four parties were started into the field before the end of the fiscal year. They included three combined topographic and geologic parties and one special topographic party, comprising three geologists and four topographers. The results of their surveys will not be known till the end of the field season of 1926.

Philip S. Smith, chief Alaskan geologist, and Gerald FitzGerald, topographer, left February 8 to continue the mapping of Naval Petroleum Reserve No. 4, on the Arctic slope of Alaska. They proceeded by the same route and same means as the party of FitzGerald and W. R. Smith in 1925 and obtained their provisions at Kotzebue, reaching their field of work before the snow melted. They were beyond means of communication with the Washington office from April 10 to the end of the fiscal year.

R. H. Sargent, topographer, was detailed as special representative of the Geological Survey to accompany the party organized by the Bureau of Aeronautics of the Navy Department to carry on aerial photographic surveys in southeastern Alaska and left Washington to join the party at Ketchikan in May. The work of this expedition is the first attempt to use the aerophotographic method of mapping in Alaska.

S. R. Capps, geologist, and K. W. Trimble, topographer, left in May to carry on geologic and topographic surveys in a district which includes the headwaters of Skwentna River and the South Fork of Kuskokwim River. This district has been hitherto unmapped.

J. B. Mertie, jr., geologist, and J. O. Kilmartin, topographer, sailed for Alaska in May to carry on geologic and topographic surveys on the Sheenjek and other northern tributaries of Porcupine River in northeastern Alaska. This district also had not previously been mapped.

MINERAL-LEASING WORK

The work of the Alaskan branch was enlarged at the beginning of the fiscal year 1926 by the transfer from the Bureau of Mines of certain functions which were given up when that bureau was transferred from the Department of the Interior to the Department of Commerce. These functions include the supervision of the production of coal and oil on public lands in Alaska under the mineral-leasing acts and, by agreement with the Bureau of Mines, the supervision of mine safety and investigative work. The supervision of leased mineral lands is administered in cooperation with the conservation branch, which does the necessary office work and advises the Alaskan branch with respect to the general conduct of work in the field. The following persons connected with the work of the Bureau of Mines in Alaska and resident in the Territory were transferred to the Alaskan branch on July 1, 1925: B. D. Stewart, supervising mining engineer; J. J. Corey, coal-mining assistant; J. G. Shepard, metal-mining assistant; Ilona M. Grover, junior clerk. H. H. Townsend, associate mining engineer, was employed from July 15, 1925, to January 15, 1926. The force was enlarged in June, 1926, by the addition of N. L. Wimmeler, mining engineer, and F. W. Holzheimer, associate mining engineer.

The following table shows the manner in which the funds available for the supervision of mineral leasing have been used:

Expenditures from funds transferred to the Geological Survey from the appropriation for the work of the Bureau of Mines in Alaska

Administration (services rendered by other survey units, accounting, etc.)-----	\$540
Technical salaries-----	13,425
Clerical salaries-----	1,500
Field expenses-----	8,095
Budget reserve-----	440
	<hr/> 22,000

B. D. Stewart spent the major part of his time in the routine supervisory and administrative work of the office at Anchorage, in conferences with officials of the Federal Government and of the Territory, and in the preparation of official reports.

J. J. Corey inspected coal mines in different parts of Alaska, particularly in the Bering River, Matanuska, and Nenana River districts, and consulted with the operators concerning methods and plans for mining and marketing Alaskan coal.

J. G. Shepard inspected metal mines in southern and southeastern Alaska and made reports on prospects and properties.

H. H. Townsend was employed from the beginning of the fiscal year until January 15, 1928, in the examination of metal prospects and mines and the preparation of reports on them.

Ilona M. Grover handled the clerical work of the Anchorage office.

TOPOGRAPHIC BRANCH**ORGANIZATION**

The organization of the topographic branch at the end of the year is shown below.

Chief topographic engineer, C. H. Birdseye.

Atlantic division, division engineer in charge, Glenn S. Smith. (In the absence of Mr. Birdseye Mr. Smith acted as chief topographic engineer.)

Central division, division engineer in charge, W. H. Herron.

Pacific division, division engineer in charge, T. G. Gerdine.

Section of inspection and editing, topographic engineer in charge, W. M. Beaman.

Section of computing, geodetic engineer in charge, S. S. Gannett.

Section of photographic mapping, engineer in charge, T. P. Pendleton.

Section of cartography, engineer in charge, A. F. Hassan.

Section of relief maps, engineer in charge, R. W. Berry.

Map information office, engineer in charge, J. H. Wheat.

Each of the three topographic field divisions was reorganized during the year to provide for four areal sections, each under the supervision of a topographic engineer.

PERSONNEL

The technical force was increased by the appointment of 3 junior topographic engineers and the reinstatement or transfer of 1 associate topographic engineer, 1 assistant topographic engineer, 2 junior topographic engineers, 1 senior engineering draftsman, and 1 printer-photographer. The force was reduced by 18 resignations, 4 transfers, and 1 retirement. With these changes the corps now includes 1 chief topographic engineer, 3 senior topographic engi-

neers in charge of divisions, 11 topographic engineers, 2 geodetic engineers, 2 topographic and geodetic engineers, 55 associate topographic engineers, 8 associate geodetic engineers, 5 associate topographic and geodetic engineers, 6 associate cartographic engineers, 24 assistant topographic engineers, 2 assistant geodetic engineers, 2 assistant topographic and geodetic engineers, 11 junior topographic engineers, 7 chief engineering field aids, 6 senior engineering field aids, 6 assistant engineering field aids, 10 apprentice engineering field aids, 1 chief engineering aid, 1 printer-photographer, 11 engineering draftsmen of various grades, and 1 junior scientist (computer), a total of 175. During the year 4 associate topographic engineers, 2 associate geodetic engineers, 3 junior topographic engineers, 1 chief engineering field aid, 2 senior engineering field aids, 1 assistant engineering field aid, and 12 apprentice engineering field aids were on furlough for the whole or a part of the year. The clerical force comprises 16 clerks of various grades, 1 of whom is a per diem employee, and 1 assistant messenger.

PUBLICATIONS

The published work of the topographic branch for the fiscal year consisted of 61 new standard topographic maps, 15 new editions of topographic maps, 43 river plans and profiles, 1 new edition of a State map (Virginia), a new edition of the Washington (D. C.) road map, special editions of topographic maps of the proposed Shenandoah and Great Smoky Mountains National Parks, advance photolithographic prints of 151 new topographic maps now in process of engraving, and 50 photolithographs of new topographic maps for which publication has not yet been otherwise provided. Additional publications were shaded relief editions of a State map of Arizona and of a standard topographic map of a quadrangle in Kentucky-Illinois.

Bulletin 766, "Spirit leveling in California, 1896-1923," a consolidation of chapters previously issued separately, was published during the year. Parts A, Administration, D, Leveling, and F, Photographic mapping, of a new bulletin to be entitled "Topographic instructions of the United States Geological Survey" were transmitted for publication. Part E, Topographic mapping, is in preparation. A three-reel film, entitled "The making of a topographic map," was prepared from field and office pictures taken in 1924-25.

APPROPRIATIONS

The Federal appropriations for topographic surveys for the fiscal year 1926 were as follows:

Topographic surveys.....	\$558, 300. 00
Salaries, scientific assistants.....	11, 000. 00
Special funds for military mapping (contributed by War and Navy Departments).....	13, 795. 19
	<hr/> 583, 095. 19

COOPERATION

Cooperation has been maintained in 24 States and 1 Territory, which contributed the following amounts:

Alabama	\$6,734.48	New York	\$11,997.71
Arizona	24,898.30	North Dakota	10,716.20
California	22,911.75	Oregon	3,587.97
Colorado	12,610.70	Pennsylvania	18,864.77
Delaware	12,570.75	Tennessee	20,892.24
Georgia	3,912.14	Texas	42,942.90
Hawaii	27,122.91	Utah	5,609.39
Idaho	1,499.87	Vermont	4,956.44
Illinois	47,495.99	Virginia	11,897.82
Iowa	2,065.33	West Virginia	936.00
Maine	4,884.41	Wisconsin	12,459.54
Michigan	10,796.90		
Missouri	10,612.92		
New Hampshire	11,972.71		
			344,950.14

In addition base-map work was executed for other Federal organizations at the following cost: For the Appalachian Park Commission, \$94.18; for the National Park Service, \$166.79; for the Federal Board for Vocational Education, \$13.89; for the Federal Power Commission, \$526.80—a total of \$801.66.

The total amount expended from all sources for the work of the topographic branch was \$927,846.16.

SUMMARY OF RESULTS

The condition of topographic surveys to June 30, 1926, is shown in the following table. The new area mapped during the year was 15,535 square miles, making the total area surveyed to date in the continental United States, exclusive of Alaska, 1,280,919 square miles, or 42.3 per cent of the entire country. In addition, 1,973 square miles of resurvey was completed, making a total area of surveys during the year 17,508 square miles. River surveys amounting to 507 linear miles were also made.

In connection with these surveys 5,591 linear miles of levels were run, making 317,964 miles of levels run since the authorization of this work by Congress in 1896. In the course of this work 1,643 permanent bench marks were established. Triangulation stations to the number of 153 were occupied, and 159 were permanently marked. Transit-traverse lines aggregating 5,021 miles were run, in connection with which 1,332 permanent marks were set.

In addition, 838 square miles of topographic mapping was completed in Hawaii, 3 triangulation stations were occupied, and 2 permanent marks set.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1925, to June 30, 1926

State	New area mapped July 1, 1925, to June 30, 1926	Total area mapped to June 30, 1926	Percentage of total area of State mapped to June 30, 1926	State	New area mapped July 1, 1925, to June 30, 1926	Total area mapped to June 30, 1926	Percentage of total area of State mapped to June 30, 1926
	Sq. miles	Sq. miles			Sq. miles	Sq. miles	
Alabama.....	314	20,471	39.4	New Hampshire.....	798	5,296	56.7
Arizona.....	1,392	50,972	50.0	New Jersey.....		8,224	100.0
Arkansas.....		21,494	40.3	New Mexico.....		40,412	32.9
California.....	700	124,351	78.6	New York.....		49,245	100.0
Colorado.....	906	54,601	82.5	North Carolina.....		19,003	36.2
Connecticut.....		4,965	100.0	North Dakota.....	432	10,449	14.8
Delaware.....		2,370	100.0	Ohio.....		41,040	100.0
District of Columbia.....		70	100.0	Oklahoma.....		39,908	57.0
Florida.....		4,716	8.0	Oregon.....	991	29,551	30.6
Georgia.....		24,835	41.9	Pennsylvania.....	652	33,290	73.8
Idaho.....		29,706	35.4	Rhode Island.....		1,248	100.0
Illinois.....	407	27,791	49.0	South Carolina.....		13,737	44.3
Indiana.....	899	3,662	10.1	South Dakota.....		19,243	24.8
Iowa.....	18	12,720	22.7	Tennessee.....	492	22,291	53.0
Kansas.....	137	64,159	78.0	Texas.....	1,309	85,551	33.1
Kentucky.....		20,723	51.0	Utah.....	428	18,856	22.2
Louisiana.....		8,810	18.2	Vermont.....	283	6,940	72.5
Maine.....	292	11,935	36.1	Virginia.....	268	37,392	87.7
Maryland.....		12,327	100.0	Washington.....	297	34,439	49.8
Massachusetts.....		8,266	100.0	West Virginia.....		24,170	100.0
Michigan.....	336	11,489	19.8	Wisconsin.....	503	16,950	30.2
Minnesota.....		7,354	8.7	Wyoming.....		30,102	30.7
Mississippi.....		3,881	8.3				
Missouri.....	360	42,745	61.6	Total continental United States (exclusive of Alaska).....	15,535	1,280,919	42.3
Montana.....		41,590	28.5	Hawaii.....	838	4,990	77.4
Nebraska.....		27,117	35.0				
Nevada.....	3,321	44,462	40.2				

In addition the following areas were resurveyed: Delaware, 262 square miles; Georgia, 175; Illinois, 670; New York, 587; Oklahoma, 52; Tennessee, 51; Texas, 166; total, 1,973.

NOTE.—The index map showing areas covered by topographic surveys was last published as Plate I of the Forty-sixth Annual Report and will hereafter be published only at intervals of several years. Index maps showing the progress of topographic mapping in the separate States may be obtained free on application to the Director, Geological Survey, Washington, D. C.

GENERAL OFFICE WORK

Computations for vertical and horizontal control were made, and the results were copied and cataloged by the computing section. The section of relief maps completed shaded relief maps of Arizona, Tennessee, and the Cave in Rock quadrangle, Kentucky-Illinois, and special relief maps of Oregon and Washington and a part of Idaho. The map information office was engaged in indexing and cataloging map data available in the several Federal departments and from commercial sources and in furnishing miscellaneous map information to Government offices and to the public. The compilation of a gazetteer of the lakes of New York was completed.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

The section of inspection and editing of topographic maps continued to supervise the office preparation of all topographic maps and to inspect and edit them before reproduction. It also edited a number of maps submitted by other Geological Survey branches and Government bureaus.

The number of topographic maps and projects in progress in the topographic branch (exclusive of those being engraved and printed) increased from 197 in July to 292 in December; the monthly average was 250. An average of 21 employees were engaged in this section for the year, including an average of 2 temporarily assigned for drafting.

James McCormick spent nine months of the year in work for the United States Geographic Board and in other special investigations and three months in revising the "Geographic dictionary of Alaska."

The work of this section is described further under "Publication branch" (p. 90).

SECTION OF PHOTOGRAPHIC MAPPING

Cooperative work in photographic mapping was continued with the Air Service, United States Army, and the Bureau of Aeronautics, United States Navy. Partial culture and drainage bases were prepared for surveys of 20 quadrangles in Texas, 14 quadrangles in Illinois, 5 quadrangles in New Hampshire, and 1 quadrangle in Michigan, also for the resurvey of 5 quadrangles in New York, 1 quadrangle in Illinois, and 1 quadrangle in Delaware. Eight special bases were prepared for reclamation surveys in Texas, for special surveys in Illinois, 1 for military surveys in Indiana, and 1 for a large-scale map of the city of Bloomington-Normal, Ill.

SECTION OF CARTOGRAPHY

The compilation of the new wall map of the United States was continued, 90 per cent being completed. The State map of Idaho was revised and a new map of Florida was compiled. A map of the air route between Montgomery, Ala., and Columbia, S. C., was compiled for the Air Service, United States Army, and a map of the northern Great Plains was compiled for the conservation branch. The United States part of sheet G-14 of the international map was completed, and preliminary work was done on sheets K-16 and I-12 and on the United States part of sheet M-13. River survey maps of streams in Washington were drafted. Graphs were prepared for the Federal Board for Vocational Education. A metal plate for use in mechanically constructing a Lambert projection on the scale of 1:500,000 for any area of the United States was designed and made.

ATLANTIC DIVISION

Alabama.—In cooperation with the State geologist of Alabama the survey of the Barton and Samantha quadrangles was completed, 314 square miles being mapped (scale 1:62,500, contour interval 20 feet); 182 miles of levels¹ and 90 miles of transit traverse were run and 74 permanent marks set.

Delaware.—In cooperation with the State Highway Department of Delaware the resurvey of the Wyoming quadrangle was completed and the resurvey of

¹ Under the provisions of an act of Congress accurate spirit levels are run and bench marks established within all regular quadrangle areas surveyed. The levels referred to in this report (pp. 57-61), unless otherwise specified, are similar to those designated "primary levels" in previous annual reports and now designated by the Federal Board of Surveys and Maps "third-order levels."

the Deepwater quadrangle was begun (areas previously surveyed on the 1:125,000 scale as parts of the Dover and Vineland quadrangles, respectively), 262 square miles being mapped (scale 1:62,500, contour interval 10 feet); 89 miles of levels and 247 miles of transit traverse were run and 63 permanent marks set.

Georgia.—In cooperation with the State geologist of Georgia the resurvey of the Ball Ground quadrangle was begun (area previously surveyed on the 1:125,000 scale as part of the Suwanee quadrangle), 175 square miles being mapped (scale 1:62,500, contour interval 20 feet); 60 miles of levels and 68 miles of transit traverse were run and 35 permanent marks set.

Indiana.—In cooperation with Purdue University a survey of Purdue University and vicinity was made, 18 square miles being mapped (scale 1:20,000, contour interval 10 feet); 20 miles of levels and 21 miles of transit traverse were run and 20 permanent marks set.

Maine.—In cooperation with the Public Utilities Commission of Maine the survey of the Dead River and Pierce Pond quadrangles was completed and that of the Dixfield quadrangle was begun, 292 square miles being mapped (scale 1:62,500, contour interval 20 feet); 135 miles of levels were run and 29 permanent marks set.

New Hampshire.—In cooperation with the Highway Department of New Hampshire the survey of the Holderness, Penacook, and Wolfeboro quadrangles was completed and that of the Potter Place quadrangle was begun, 615 square miles being mapped (scale 1:62,500, contour interval 20 feet); 211 miles of levels, including 20 miles of "first-order levels," were run, 46 permanent marks set, and 30 triangulation stations occupied and 24 marked. In cooperation with the War Department the survey of the Indian Stream quadrangle was completed, 183 square miles being mapped (scale 1:62,500, contour interval 20 feet); 120 miles of levels were run and 34 permanent marks set.

New York.—In cooperation with the New York State engineer the resurvey of the Albany and Troy quadrangles was completed and that of the Cossack, Schenectady, and Cohoes quadrangles was begun, 587 square miles being mapped (scale 1:62,500, contour interval 20 feet); 178 miles of levels were run and 50 permanent marks set.

Ohio.—In Ohio 18 miles of levels were run and 44 permanent marks set.

Pennsylvania.—In cooperation with the Pennsylvania Department of Forests and Waters, Topographic and Geological Survey, the survey of the Mifflintown, Blossburg, Needmore, and Hawley quadrangles was completed, that of the Eagles Mere quadrangle was continued, and that of the Tidoute, Youngsville, Titusville, and Townville quadrangles was begun, 652 square miles being mapped (scale 1:62,500, contour interval 20 feet); 354 miles of levels and 352 miles of transit traverse were run and 206 permanent marks set.

Tennessee.—In cooperation with the Tennessee Department of Highways and Public Works, the survey of the Waverly-Cumden and Nashville-Clarksville highway projects was completed, 198 square miles being mapped (scale 1:24,000, contour interval 10 feet); 6 miles of levels and 244 miles of transit traverse were run and 64 permanent marks set. In cooperation with the Tennessee State geologist the survey of the Gainesboro quadrangle and of the Tennessee part of the Tompkinsville quadrangle was completed, 355 square miles being mapped (scale 1:62,500, contour interval 20 feet); 196 miles of levels and 473 miles of transit traverse were run and 192 permanent marks set.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Mount Mansfield quadrangle was completed and that of the Claremont and Averill quadrangles was begun, 283 square miles being mapped (scale 1:62,500, contour interval 20 feet).

Virginia.—In cooperation with the Director of the Geological Survey of Virginia the survey of the Rocky Mount quadrangle was completed and that of the Critz quadrangle was begun, 200 square miles being mapped (scale 1:62,500, contour interval 20 feet); 373 miles of levels, including 142 miles of "first-order levels," and 228 miles of transit traverse were run, 216 permanent marks set, and 14 triangulation stations occupied and 16 marked. In cooperation with the Marine Corps a survey of the Quantico Marine Reservation was made, 8 square miles being mapped (scale 1:10,000, contour interval 10 feet); 30 miles of levels and 230 miles of transit traverse were run and 12 permanent marks set.

West Virginia.—In cooperation with the State geologist of West Virginia the culture was revised for the Pineville, Pounding Mill, Glenville, Arnoldsburg, Mullens, Spencer, Ripley, Point Pleasant, and Ravenswood quadrangles, a total area of 1,812 square miles (scale 1:62,500, contour interval 50 feet).

Office work.—The drafting of 32 sheets and 2 projects was completed. Level circuits were adjusted for 68 quadrangles. Geographic positions were computed for 64 quadrangles.

CENTRAL DIVISION

Colorado.—In cooperation with the Colorado State Inspector of oils the survey of the Parachute Creek quadrangle was completed, 230 square miles being mapped (scale 1:62,500, contour interval 50 feet); 218 miles of levels and 33 miles of transit traverse were run, 70 permanent marks set, and 33 triangulation stations occupied and 20 marked. At the request of the Forest Service the survey of the Glenwood Springs quadrangle was begun, 550 square miles being mapped (scale 1:125,000, contour interval 100 feet); 179 miles of levels were run and 38 permanent marks set. In cooperation with the Colorado School of Mines the survey of the Grand Valley, Highmore, and Roan Creek quadrangles was begun, 126 square miles being mapped (scale 1:62,500, contour interval 50 feet); 5 triangulation stations were occupied and permanent marks set; and for the control of the Gunnison quadrangle 84 miles of levels were run and 34 permanent marks set. In cooperation with the Colorado Metal Mining Fund control work was begun on the Saguache quadrangle, 20 miles of levels being run, 12 permanent marks set, and 4 triangulation stations occupied and 4 marked.

Illinois.—In cooperation with the Department of Registration and Education of Illinois the survey of the Brighton, Streator, Gibson City, and Galesburg quadrangles and the Illinois part of the Joppa, Paduca, and Smithland quadrangles was completed and that of the Normal and Mount Sterling quadrangles was begun, 899 square miles being mapped (scale 1:62,500, contour intervals 10 and 20 feet). The resurvey of the Springfield quadrangle was begun, 205 square miles being mapped (scale 1:62,500, contour interval 10 feet). The resurvey of the Hinsdale, River Forest, Riverside No. 4, Arlington Heights, Palos Park, and Sag Bridge quadrangles was completed and that of the Riverside No. 2, Highwood No. 2, Des Plaines No. 4, Chicago No. 2, Chicago No. 3, and Evanston No. 3 quadrangles was begun (areas previously surveyed on the 1:62,500 scale as parts of the Riverside, Highwood, Des Plaines, Chicago, and Evanston quadrangles, 468 square miles being mapped (scale 1:24,000, contour interval 5 feet); 622 miles of levels and 518 miles of transit traverse were run and 307 permanent marks set.

Iowa.—In cooperation with the Director of the Iowa Geological Survey the survey of the Albia quadrangle was completed, 137 square miles being mapped (scale 1:62,500, contour interval 20 feet); 97 miles of levels were run and 18 permanent marks set.

Michigan.—In cooperation with the Department of Conservation, Geological Survey Division, of Michigan, the survey of the De Witt and Laingsburg quadrangles was completed and that of the Corunna quadrangle was begun, 336 square miles being mapped (scale 1:62,500, contour interval 10 feet); 149 miles of levels and 610 miles of transit traverse were run and 221 permanent marks set.

Missouri.—In cooperation with the State geologist of Missouri the survey of the Cardareva and Shell Knob quadrangles was completed, and that of the Des Arc quadrangle was begun, 359 square miles being mapped (scale 1:62,500, contour interval 20 feet); 176 miles of levels and 81 miles of transit traverse were run and 79 permanent marks set.

North Dakota.—In cooperation with the State engineer of North Dakota a survey of Souris River was completed, 113 square miles being mapped (scale 1:24,000, contour intervals 5 and 10 feet), and that of the Minot, Benedict, and Coleharbor quadrangles was begun, 319 square miles being mapped (scale 1:62,500, contour interval 20 feet); 355 miles of levels and 725 miles of transit traverse were run and 330 permanent marks set.

Oklahoma.—In cooperation with the University of Oklahoma a partial resurvey of the Norman No. 2 quadrangle was made, 52 square miles being mapped (scale 1:81,680, contour interval 10 feet); 16 miles of levels were run and 12 permanent marks set.

Texas.—In cooperation with the Texas Board of Water Engineers the survey of the Mathis 2 and 3, San Roque Lake 1-a, Aspermest 4-a, Crowther 3,

Simmons 1 and 2, Tilden 1, Haskell 3-b, Roby 2-b, Snyder 1-a, Segovia 2-a and 2-c quadrangles and of the North Llano Strip was completed, and that of the Mathis 4, Cadiz 3, Segovia 3-b and 2-b, Aspermost 3-c and 1-d, Haskell 2-c and 3-c, and Quanah 3-a quadrangles was begun, 841 square miles being mapped (scale 1:62,500, contour intervals 10 and 20 feet); 117 miles of levels and 10 miles of transit traverse were run and 23 permanent marks set. In cooperation with separate interests acting through the Texas Board of Water Engineers, work was begun on the survey of Neches River, 165 miles of levels and 186 miles of transit traverse being run and 120 permanent marks set. In cooperation with the State Reclamation Department of Texas the survey of the Dalworth project, sheets A, B, and C (scale 1:24,000, contour intervals 2 and 10 feet), of the Bazzette, Bazzette extension, Porters Bluff, Porters Bluff extension, Red Bank, and Club House quadrangles of the Trinity River project No. 1 (scale 1:24,000, contour intervals 2, 5, and 10 feet), and of the Cox-Cook project on Trinity River (scale 1:12,000, contour intervals 2 and 5 feet) was completed, and that of the Upper Brazos River project, Marlin to Jones Bridge (scale 1:24,000, contour intervals 2, 5, 10, and 20 feet), and of the Bluntzer project, on Nueces River (scale 1:12,000, contour intervals 2 and 5 feet), was begun, 478 square miles being mapped; 66 miles of levels and 223 miles of transit traverse were run and 66 permanent marks set. In cooperation with Orange County, Tex., 109 miles of levels and 202 miles of transit traverse were run and 69 permanent marks set. The survey of the Bassett quadrangle was begun, 174 square miles being mapped (scale 1:62,500, contour interval 20 feet).

Wisconsin.—In cooperation with the Geological and Natural History Survey of Wisconsin the survey of the Hillsboro quadrangle was completed, and that of the Whitehall, Ferryville, Galesville, Winona, and Montana quadrangles was begun, 503 square miles being mapped (scale 1:62,500, contour interval 20 feet); 318 miles of levels and 225 miles of transit traverse were run and 135 permanent marks set.

Office work.—The drafting of 45 sheets and 3 projects was completed. Level circuits were adjusted for 101 quadrangles. Geographic positions were computed for 94 quadrangles.

PACIFIC DIVISION

Arizona.—In cooperation with the State water commissioner of Arizona the survey of the Wellton Nos. 2, 3, and 4 and Mohawk Nos. 2 and 3 quadrangles was completed, and that of the Sentinel No. 2 quadrangle was begun, 1,392 square miles being mapped (scale 1:62,500, contour interval 25 feet). For these and other quadrangles 474 miles of levels and 4 miles of transit traverse were run, 52 triangulation stations occupied, and 166 permanent marks set.

California.—In cooperation with the State engineer of California the survey of the Guernsey, Corcoran, Strathmore, Waukena, Woodville, Lemon Cove, Tipton, No. 36, and No. 42 quadrangles was completed, and that of the Stratford quadrangle was begun, 540 square miles being mapped (scale 1:31,680, contour interval 5 feet); 217 miles of levels and 251 miles of transit traverse were run and 162 permanent marks set. In cooperation with Los Angeles County the survey of the San Pedro Hills, La Brea, Reseda, and Claremont quadrangles was completed, 47 square miles being mapped (scale 1:24,000, contour intervals 5 and 25 feet). At the request of the National Park Service the survey of the Lassen Volcanic National Park was begun, 113 square miles being mapped (scale 1:62,500, contour interval 50 feet); 70 miles of levels were run and 20 permanent marks set.

Hawaii.—In cooperation with the commissioner of public lands of the Territory of Hawaii the survey of the Hoopuloa NE. $\frac{1}{4}$, NW. $\frac{1}{4}$, SW. $\frac{1}{4}$, and SE. $\frac{1}{4}$; Mauna Kea NW. $\frac{1}{4}$, NE. $\frac{1}{4}$, and SW. $\frac{1}{4}$; Mauna Loa NW. $\frac{1}{4}$, NE. $\frac{1}{4}$, SE. $\frac{1}{4}$, and SW. $\frac{1}{4}$; Kaohoe NW. $\frac{1}{4}$ and SW. $\frac{1}{4}$ quadrangles and the island of Kahoolawe was completed, and that of the Waiki NE. $\frac{1}{4}$ and Kahoe SE. $\frac{1}{4}$ quadrangles was begun, 838 square miles being mapped (field scale 1:31,680, contour intervals 10 and 50 feet; publication scale 1:62,500, contour interval 50 feet); 3 triangulation stations were occupied and 2 permanent marks set.

Idaho.—At the request of the Forest Service the survey of the Casto quadrangle was continued, 330 square miles being mapped (scale 1:125,000, contour interval 100 feet). In cooperation with the Bureau of Mines and Geology of Idaho the survey of the Craters of the Moon National Monument was completed, 77 square miles being mapped (scale 1:31,680, contour interval 10

feet); 12 permanent marks were set. For the conservation branch a plan and profile of Payette River and tributaries was completed and a plan and profile survey of the Clark Fork begun, 80 square miles being mapped (scale 1:31,680, contour intervals 5, 10, and 20 feet) and 115 linear miles of river traversed; in addition 7 dam sites were surveyed (scale 1:4,800, contour interval 10 feet).

Montana.—In Montana 11 triangulation stations were occupied and 13 permanent marks set.

Nevada.—At the request of the geologic branch the survey of the Lowry Peak quadrangle was begun, 3,493 square miles being mapped (scale 1:250,000, contour interval 100 feet).

Oregon.—In cooperation with the State engineer of Oregon the survey of the Bend quadrangle was begun, 305 square miles being mapped (scale 1:125,000, contour interval 50 feet). At the request of the Forest Service the survey of the Oregon part of the Hood River quadrangle was completed and that of the Elkhorn quadrangle was begun, 630 square miles being mapped (scale 1:125,000, contour interval 100 feet); 51 miles of levels were run and 20 permanent marks set. At the request of the Carnegie Institution the survey of the Picture Gorge quadrangle was completed, 56 square miles being mapped (scale 1:48,000, contour interval 50 feet). For the conservation branch plan and profile surveys were completed for Crooked River (scale 1:12,000, contour intervals 5 and 25 feet), McKenzie River and tributaries (scale 1:31,680 and 1:4,800, contour intervals 10 and 20 feet), Siletz River and tributaries (scale 1:31,680 and 1:4,800, contour intervals 5, 10, and 25 feet) and the East Fork of Coquille River (scale 1:31,680, contour interval 10 feet), and the survey of the Middle Fork of Willamette River was begun, 202 linear miles of river being traversed; in addition 2 dam sites were surveyed (scale 1:4,800, contour interval 10 feet).

Utah.—In cooperation with Weber, Salt Lake, Davis, and Utah Counties, Utah, and the Bureau of Reclamation the survey of these counties was continued, 100 square miles being mapped (scale 1:24,000, contour interval 5 feet); 116 miles of levels were run and 32 permanent marks set. At the request of the Forest Service the survey of the east half of the Fort Douglas 30-minute quadrangle (scale 1:125,000, contour interval 100 feet) was completed, and that of the Fort Douglas Nos. 2 and 3 quadrangles (scale 1:62,500, contour interval 50 feet) was begun, 153 square miles being mapped. At the request of the geologic branch the survey of the Gold Hill quadrangle was completed, 171 square miles being mapped (scale 1:24,000 and 1:48,000, contour intervals 25 and 50 feet). In cooperation with the department of military science of the University of Utah the mapping of the Fort Douglas Military Reservation was completed, 4 square miles being mapped (scale 1:10,000, contour intervals 10 and 25 feet); 4 triangulation stations were occupied and 9 permanent marks set. For the conservation branch a plan and profile survey of San Rafael River from Castle Dale to Buckhorn Wash was completed (scale 1:31,680, contour interval 25 feet), 40 linear miles of river being traversed.

Washington.—For the Forest Service the survey of the Langille Peak quadrangle was completed, 297 square miles being mapped (scale 1:125,000, contour interval 100 feet). For the conservation branch a plan and profile survey of the North Fork and South Fork of Stikiamish River was completed, 48 linear miles of river being traversed (scale 1:31,680, contour intervals 5 and 25 feet). In addition dam and reservoir sites were surveyed covering 22 square miles (scale 1:15,840 and 1:4,800, contour interval 5 feet).

Office work.—The drafting of 50 sheets and 19 projects was completed. Level circuits were adjusted for 44 quadrangles. Geographic positions were computed for 27 quadrangles.

WATER-RESOURCES BRANCH

ORGANIZATION

The work of the water-resources branch was conducted under the supervision of N. C. Grover, chief hydraulic engineer, and is organized in five divisions:

Division of surface water, John C. Hoyt, hydraulic engineer, in charge.
Division of ground water, O. E. Meinzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

Division of land-classification investigations, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL

During the year the technical force was reduced 12 and was increased 9, a net decrease of 3. At the end of the year the force consisted of 1 chief hydraulic engineer, 1 senior hydraulic engineer, 31 hydraulic engineers, 5 associate hydraulic engineers, 2 engineers, 7 associate engineers, 26 assistant engineers, 33 junior engineers, 2 geologists, 2 associate geologists, 2 assistant geologists, 2 chemists, and 1 assistant chemist, a total of 115. Of this number, 2 hydraulic engineers, 1 associate hydraulic engineer, 1 engineer, 3 assistant engineers, 3 junior engineers, and 1 assistant geologist were employed occasionally.

In the clerical force there were 9 separations and 7 accessions, and at the end of the year the force numbered 25. Of this number 4 have been employed only at times.

ALLOTMENTS

The appropriation for gaging streams was \$165,000. In addition \$56,000 of the appropriation for the classification of lands was expended for field work by the water-resources branch. Of the total appropriations 60 per cent was allotted to work in public-land States. The cooperative funds made available by State allotments have been increased in some States and decreased in others, and the changes have necessitated corresponding adjustments of this work. The amount of these funds available for the year was \$307,490.98. With repayments for services rendered to other branches of the Government (\$34,345.86) the total expenditures for work under the administration of this branch were \$562,836.84.

Allotments of funds for gaging streams, 1925-26

Administration, general.....	\$15, 179. 42	Surface water—Contd.	
Branch administration.....	10, 865. 00	Montana.....	\$4, 300. 00
Inspection.....	1, 000. 00	Utah.....	4, 300. 00
Computations.....	12, 510. 00	Nevada.....	2, 500. 00
	<hr/>	Idaho (Boise).....	3, 200. 00
	39, 554. 42	Idaho (Idaho Falls)...	1, 000. 00
	<hr/>	Oregon.....	4, 300. 00
Surface water:		Washington.....	4, 300. 00
New England.....	5, 000. 00	California.....	4, 500. 00
New Jersey.....	3, 000. 00	Arizona.....	3, 300. 00
New York.....	4, 500. 00	Hawaii.....	4, 500. 00
Middle Atlantic			<hr/>
States.....	3, 600. 00		85, 400. 00
North Carolina.....	3, 600. 00		<hr/>
Tennessee.....	3, 000. 00	Ground water.....	15, 665. 00
Ohio.....	3, 500. 00	Quality of water.....	11, 350. 00
Texas.....	4, 300. 00	Power resources.....	7, 700. 00
Wisconsin and Min-		General supplies.....	500. 00
nesota.....	3, 500. 00	Books for library.....	150. 00
Iowa.....	2, 000. 00	Contingent.....	4, 680. 58
Illinois.....	1, 500. 00		<hr/>
Missouri.....	3, 600. 00		Grand total.....
Kansas.....	3, 000. 00		165, 000. 00
Colorado, Wyoming,			
and New Mexico..	5, 000. 00		

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated in furnishing office quarters and occasional services in field and office.

Alabama.....		\$80.00
Arizona:		
Stream gaging.....	\$10,000.00	
Colorado River.....	7,000.00	
		17,000.00
California:		
State.....	23,126.52	
County and city (gaging streams).....	10,022.24	
Municipal (ground water).....	1,949.59	
		35,098.35
Colorado:		175.00
Hawaii:		
Territory.....	32,392.08	
Municipal.....	4,461.13	
		36,853.21
Idaho State Department of Reclamation:		
Outside of upper Snake River basin.....	13,016.25	
Upper Snake River basin.....	2,200.98	
		15,217.23
Illinois:		
State.....	4,163.26	
Municipal.....	60.00	
		4,223.26
Iowa:		
State College Engineering Experiment Station.....	1,558.43	
State Geological Survey.....	504.17	
		2,062.60
Kansas:		
State.....	2,148.48	
Municipal.....	60.00	
		2,208.48
Maine.....		5,106.95
Maryland.....		168.54
Massachusetts.....		3,899.11
Minnesota.....		292.51
Missouri.....		9,926.94
Montana.....		4,952.75
Nevada.....		3,664.13
New Hampshire.....		1,681.89
New Jersey:		
Stream gaging.....	11,796.59	
Ground water.....	7,382.73	
		19,179.32
New Mexico:		
State.....	5,500.00	
Municipal.....	75.00	
		5,575.00
New York:		
State.....	15,492.00	
Municipal.....	84.00	
		15,576.00
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North Carolina:		
State.....	\$6, 206. 42	
Municipal	1, 741. 74	
		\$8, 038. 16
Ohio		24, 684. 23
Oregon.....		8, 041. 93
Pennsylvania		400. 00
Tennessee		10, 189. 09
Texas:		
State Board of Water Engineers.....	35, 039. 24	
State Reclamation Department.....	685. 73	
		36, 324. 97
Utah.....		6, 953. 46
Virginia.....		10, 340. 34
Washington:		
State.....	5, 085. 98	
Municipal	2, 088. 14	
		7, 774. 12
West Virginia.....		498. 72
Wisconsin		6, 154. 41
Wyoming.....		4, 570. 28
		307, 490. 98

The work done under cooperative agreements with the States has been restricted to studies of stream flow, except in Arizona, New Jersey, New Mexico, North Dakota, and Pennsylvania, where ground-water investigations also have been made. (See pp. 67-69.)

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects under construction was continued in cooperation with the Bureau of Reclamation. The field work was done by Geological Survey engineers, who were employed where the measurements were made, and the cost was met by the Bureau of Reclamation through transfer of funds. Geologic investigations of reservoir and dam sites were made for the Bureau of Reclamation in New Mexico, Oregon, and Washington. (See pp. 69-70.)

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued in the Colville, Western Shoshone, and Walker River Reservations and on Gila and San Carlos Rivers and for a short time in the Uinta Reservation. A geologic investigation for a ground-water supply was made in the vicinity of Canton, S. Dak.

National Park Service.—Streams in the Yosemite and Yellowstone National Parks were measured during the year at stations maintained in cooperation with the National Park Service. An investigation and report were made for an enlarged water supply in the Mesa Verde National Park.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service. A report was submitted on water supplies for live stock in the Helena National Forest, Mont.

Veterans' Bureau.—Geologic investigations were made of water supplies for hospitals at Perry Point, Md.; Bedford, Mass.; and Tupper Lake, N. Y.

Weather Bureau.—Stream gaging has been done on Colorado River in Arizona in cooperation with the Weather Bureau.

Federal Power Commission.—Projects of the Federal Power Commission in Arizona and Wyoming were examined, and the examina-

tion of one in Oregon and one in Utah is in progress. The operations of 1 licensee of the commission in Arizona, 12 in California, 1 in Colorado, 1 in Idaho-Oregon, 5 in Idaho, 1 in Montana, 1 in Nevada, 6 in Oregon, 1 in Utah, and 5 in Washington were supervised by the Geological Survey, as well as the operations of 2 permittees of the commission in Arizona, 1 in Colorado, 3 in Idaho, 1 in Oregon, and 1 in Utah-Wyoming. All stream gaging by permittees of the commission is done in cooperation with the Geological Survey. Such cooperative stream gaging is in progress in Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Montana, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

Office of the Chief of Engineers.—Stream gaging has been done in the basins of Tennessee and Cumberland Rivers in cooperation with the office of the Chief of Engineers.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 22 reports and 1 separate chapter. Titles and brief summaries of these publications are given on pages 11–13. At the end of the year 14 other reports were in press and 21 manuscripts were awaiting editorial work.

DIVISION OF SURFACE WATER

ORGANIZATION

The work of the division of surface water consists primarily of the measurement of the flow of rivers, but it includes also special investigations of conditions affecting stream flow and the utilization of the streams. In carrying on the work the United States is divided into 23 districts, including Hawaii. The district offices and engineers in charge are as follows:

- New England: H. B. Kinnison, Customhouse, Boston, Mass.
- New York: A. W. Harrington, Journal Building, Albany, N. Y.
- New Jersey: O. W. Hartwell, Statehouse, Trenton, N. J.
- Middle Atlantic: A. H. Horton, Washington, D. C.
- Virginia: J. J. Dirzulaitis, University of Virginia, Charlottesville, Va.
- South Atlantic: E. D. Burchard, Jackson Building, Asheville, N. C.
- Tennessee: W. R. King, Municipal Building, Chattanooga, Tenn.
- Ohio: Lasley Lee, Ohio State University, Columbus, Ohio.
- Wisconsin-Minnesota: S. B. Soule, Capitol Building, Madison, Wis.
- Illinois: H. E. Grosbach, Transportation Building, Chicago, Ill.
- Kansas-Iowa: J. B. Spiegel, Federal Building, Topeka, Kans.; suboffice, State Highway Commission Building, Ames, Iowa.
- Missouri: H. C. Beckman, Rolla, Mo.
- Montana: W. A. Lamb, Federal Building, Helena, Mont.
- Colorado-Wyoming: Robert Follansbee, Post Office Building, Denver, Colo.
- Utah-Nevada: A. B. Purton, Federal Building, Salt Lake City, Utah.
- Idaho: C. G. Paulsen, Federal Building, Boise, Idaho.
- Snake River basin: G. C. Baldwin, Federal Building, Idaho Falls, Idaho.
- Washington: G. L. Parker, Federal Building, Tacoma, Wash.
- Oregon: F. F. Henshaw, Post Office Building, Portland, Oreg.
- California: H. D. McGlashan, Customhouse, San Francisco, Calif.; suboffice Federal Building, Los Angeles, Calif.
- Arizona: W. E. Dickinson, University of Arizona, Tucson, Ariz.
- Hawaii: Max H. Carson, Capitol Building, Honolulu, Hawaii.
- Texas: C. E. Ellsworth, Capitol Building, Austin, Tex.

CHARACTER AND METHOD OF WORK

Field investigations necessary to the work are made from the district offices, where the results are examined and corrected, if correction is necessary, to insure their accuracy and completeness. At selected gaging stations the volume of water carried by the streams is measured and records of stage and other data are collected from which the daily flow of the streams is computed. The data thus collected are transmitted from the district offices to Washington, where they are reviewed in the computing section and prepared for publication. By this review the records obtained in different parts of the country are brought to a uniform standard, and standardization is further effected through annual conferences of the engineers.

At the end of the year 1,730 gaging stations were being maintained, including 78 in Hawaii; 290 stations were discontinued and 305 new stations established during the year. Records for about 130 additional stations were received, ready for publication, from Government bureaus and private persons, and a number of Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

Gaging stations and cooperating parties for the year ended June 30, 1926

State or Territory	Geological Survey alone	Bureau of Reclamation	Forest Service	Indian Office	Army engineers	Weather Bureau	Other Federal bureaus	State cooperation	Municipal cooperation	Private persons	Counted more than once	Maintained at end of year	Established during year	Discontinued during year	Regular gagings during year	Miscellaneous during year
Alabama.....					2			1		8	1	10	1	4	31	3
Arizona.....		2		3		3	4	39	4	4	20	39	3		832	
Arkansas.....										2		2			16	
California.....		20	1				5	224	59	103	186	226	21	4	3,653	513
Colorado.....		2						30	3	7	10	32	3	3	116	40
Connecticut.....										2		2			8	
Florida.....										2		2	2	1	6	
Georgia.....										2		2			39	10
Idaho.....		6	6			2		113	3	211	98	243	130	135	2,381	420
Illinois.....					2	2		31	1	1	6	31	4		65	
Indiana.....								1		2	1	2	2		5	
Iowa.....						6		11		6	2	21		6	50	4
Kansas.....						3		24	1	3	7	24		6	77	
Kentucky.....					12					14	12	14	6	5	91	
Louisiana.....														3	6	
Maine.....								17		5	5	17	1	1	81	1
Maryland.....	2							2	2	2	2	6	1	1	45	
Massachusetts.....								18		1	1	18			123	3
Michigan.....										2		2			4	2
Minnesota.....					2			7		7		16	3	1	16	
Missouri.....					1	1		57		16	18	57	4	2	337	40
Montana.....	6	18	2				15	33		6	14	66	2	7	229	
Nevada.....				3				19	2	6	11	19		3	67	1
New Hampshire.....								15		11	11	15			32	
New Jersey.....						1		36	7	5	13	36	1	1	256	57
New Mexico.....		1										1			2	
New York.....					1			74	2	39	42	74	10	6	480	22
North Carolina.....					1	1		54	12	11	22	57	15	5	308	45
North Dakota.....														9		
Ohio.....					5	2		58	13	6	1	83	16		290	23
Oklahoma.....										2		2	1	5	19	
Oregon.....			1					91	27	49	84	91	14	10	710	103
South Carolina.....										4		4		1	13	
Tennessee.....					50	8		55		8	66	55	13	1	392	25
Texas.....						11	5	115	17	18	51	115	1	34	1,032	265
Utah.....		1		5			1	54	2	17	26	54	3		184	122
Vermont.....										5				2	7	
Virginia.....						1		48		11	12	48	22	8	128	23
Washington.....	1		3	4			2	44	22	26	44	58	5	12	368	66
West Virginia.....					5			5	1	13	2	22	7	4	27	
Wisconsin.....					3			40		9	12	40		3	106	8
Wyoming.....		6		4		1	6	21		3	5	36		4	127	3
Hawaii.....								78	6	17	23	78	6	1	366	234
	9	36	32	20	84	49	38	1,415	184	671	808	1,730	305	290	13,143	1,74

PUBLICATIONS

For convenience and uniformity in publication, the United States has been divided into 12 primary drainage basins, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions; the records for the twelfth division are published in three papers. In addition to the progress reports, special reports on hydraulic subjects have been completed for publication during the year.

DIVISION OF GROUND WATER

GENERAL FEATURES

The division of ground water investigates the waters that lie below the surface—their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to the chemical composition of the water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects. A number of investigations on the geology of reservoir sites have also been made for the Bureau of Reclamation and the Federal Power Commission. During the year more than 40 investigations relating to ground water or reservoir sites were conducted in 19 States and in the Territory of Hawaii. Twenty investigations were completed and reports thereon submitted.

In some parts of the country the demand for ground water for public or irrigation supplies has become so great that all the available water is needed, and there is grave danger of overdevelopment. In these areas exact information is demanded as to the quantity of water available and the most efficient methods for its full utilization. These demands have led to a number of intensive quantitative investigations, the most important of which now in progress are the investigations by D. G. Thompson in New Jersey, by A. G. Fiedler in the Roswell artesian basin of New Mexico, and by W. N. White in the Escalante Valley in Utah.

During the year the following general papers were completed for publication as water-supply papers or contributions to hydrology: "Methods of exploring and repairing leaky artesian wells," by John McCombs and A. G. Fiedler; and "Laboratory tests on physical properties of water-bearing materials," by Mrs. N. D. Stearns. Progress was also made by Mr. Meinzer on his paper on the origin, discharge, and quantity of ground water in the United States, and by Mrs. Stearns on her paper on thermal springs in the United States. Through hearty cooperation by the Forest Service and the Office of Indian Affairs a large number of original data on thermal springs were obtained.

Cooperation with the committee on physiography was continued through Messrs. Meinzer and Bryan. Several manuscripts were examined for the geologic branch with respect to their treatment of ground water. Mr. Meinzer cooperated with a committee of the North Dakota Well Drillers' Association on specifications for a class A farm well.

WORK OF THE YEAR BY STATES

Arizona.—Some progress was made on a report on the geology and water resources of San Pedro Valley, Ariz., by Kirk Bryan, of the Geological Survey, and G. E. P. Smith, of the Arizona Agricultural Experiment Station.

Arkansas.—Studies of the temperature and mineral composition of the water of Hot Springs National Park, Ark., were continued by Mr. Bryan in cooperation with W. D. Collins.

California.—Water levels were measured in selected wells in southern California, as in previous years, under the direction of F. C. Ebert. The record now covers a period of 22 years, with measurements of one well during a period of 34 years. Work was begun in April by H. T. Stearns, assisted by T. W. Robinson, on an investigation of ground water in the alluvial fan of Mokelumne River, in cooperation with the East Bay Municipal Utility district.

Colorado.—An examination of the water resources of the Mesa Verde National Park was made by Mr. Meinzer, who prepared a report for the National Park Service, with recommendations for enlarging the supply.

Hawaii.—The report by H. T. Stearns and W. O. Clark on the geology and water resources of the Kau district, Island of Hawaii, was nearly completed. Work on the artesian wells in the vicinity of Honolulu, by John McCombs, was conducted under the supervision of M. H. Carson, district engineer.

Idaho.—Observations were continued in the Mud Lake basin through cooperation with C. G. Paulsen, district engineer. Progress was made by Mr. Stearns on the final report on this basin. Mr. Stearns made a brief examination and report on the leakage of the Malad reservoir, collected samples of gas from the Soda Springs, and cooperated with A. M. Piper, of the Idaho Bureau of Mines and Geology, in an examination for an enlarged water supply for the city of Pocatello.

Iowa.—An examination was made by Mr. Meinzer on the ground-water resources of Sheldon, Iowa, and a report thereon was submitted to the city authorities.

Maryland.—An examination and report were made by G. M. Hall for the Veterans' Bureau on a ground-water supply for the hospital at Perry Point, Md.

Massachusetts.—An examination was made by Mr. Bryan of ground-water supplies available for a proposed veterans' hospital at Bedford, Mass., and a report with recommendations was submitted to the Veterans' Bureau.

Montana.—A report on the geology and ground water in central and southern Rosebud County, Mont., by B. C. Renick, with chemical analyses of the waters, by H. B. Riffenburg, was completed and is to be published as a water-supply paper. Some progress was made by Mr. Hall on his reports on Big Horn and Fergus Counties. A report by Mr. Bryan on water supplies in the Helena National Forest was submitted to the Forest Service.

New Jersey.—The investigation of the quantities of ground water available for public and industrial supplies in New Jersey was continued during the year in cooperation with the State Department of Conservation and Development. The work was in charge of D. G. Thompson, who was assisted by E. W. Downs. A report on ground-water conditions and problems in the State was published in the report of the State Water Policy Commission. A brief report outlining work done during the last two years and a detailed report on the Atlantic City region were submitted for publication by the State. A paper on ground-water conditions on the barrier beaches of New Jersey was presented by Mr. Thompson at the New Haven meeting of the Geological Society of America and is to be published in the bulletin of that society. Reports are in preparation by Mr. Thompson on the Camden, Asbury Park, Princeton, and Newark areas, on tidal fluctuations in wells, and on methods of measuring water levels in wells. Observations are being continued at the hydrologic experiment stations at Atlantic City and Runyon.

water-stage recorders were in service on 16 wells at various times during year and on 10 wells at the end of the year. About 1,000 measurements he depth to water were made.

ew Mexico.—Work was done on five ground-water investigations in New ico in cooperation with the State engineer. These investigations relate he ground-water resources of Sandoval, DeBaca, and Socorro Counties, the nage basin of Penasco River, and the Roswell artesian basin. Additional l work was done by Mr. Renick in Sandoval County, and a report with mmendations for drilling test wells was submitted to the State engineer. examination was also made in the basin of Penasco River by Mr. Renick. eport on this basin with recommendations was submitted to the State ineer and is also to be published as a contribution to hydrology. An inv- ine investigation of the water supply of the Roswell artesian basin was an by A. G. Fiedler, and measurements of underground leakage from arte- wells were made by him with an Au deep-well current meter. Preliminary l work was done by Mr. Bryan in DeBaca and Socorro Counties. An stigitation was made for the Bureau of Reclamation by Messrs. Meinzer, ick, and Bryan, of the geology of the No. 3 reservoir site of the Carlsbad lect with respect to water-tightness. A report on the subject was submitted he Bureau of Reclamation and is in press as a contribution to hydrology. Meinzer cooperated with E. H. Wells, State geologist, in an examination he water resources in the vicinity of Silver City. A report on the subject been submitted to the mayor of the city.

ew York.—An examination and report concerning a water supply for the erans' Hospital near Tupper Lake, N. Y., was made by Mr. Bryan.

outh Carolina.—Additional work was done by Mr. Meinzer on the investi- on by the United States Public Health Service on pollution of ground er at the experiment station at Fort Caswell, N. C.

orth Dakota.—A comprehensive report on the geology and ground-water ources of North Dakota, by H. E. Simpson, with a discussion of the chemical racter of the water, by H. B. Riffenburg, was completed and is to be pub- ed as a water-supply paper.

regon.—A report by Mr. Bryan on the geology of the dam site and tunnel or the Owyhee irrigation project, Oregon, was submitted to the Bureau eclamation. A paper on the petrography of the rocks of this area, by Mr. ick, was submitted to the geologic branch. Mr. Stearns investigated the logy and ground-water conditions of certain reservoir sites on Crooked er and prepared a report thereon with recommendations for the Federal ver Commission. Messrs. Henshaw and Stearns made observations on large lngs in Oregon for use in the forthcoming water-supply paper on large lngs in the United States. They also made observations on the geyser wells he vicinity of Lakeview.

ennessee.—A survey of the ground waters of the State was undertaken ooperation with the State geologist. An area of 14 counties in the south- ern part of the State was covered by Mr. Hall, who is preparing a water- ply paper on the area.

outh Carolina.—Progress was made on a report on the ground water in the stal Plain of South Carolina, by C. W. Cooke, of the geologic branch.

outh Dakota.—An investigation of the soft-water horizon in the vicinity of ton, S. Dak., was made by Mr. Meinzer, and a report was prepared by or the Office of Indian Affairs with recommendations concerning a soft- er supply for the Hospital for Insane Indians at Canton. A copy of the ort was also furnished to the mayor of Canton because of its bearing on public supply of the city.

Utah.—The intensive study of the intake and discharge of ground water in alante Valley, Utah, was continued by W. N. White. A hydrologic experi- it station was maintained at Milford, and water-stage recorders were in- led over several wells to ascertain the daily fluctuations in the water table nced by discharge of ground water due to transpiration of alfalfa and of ain desert plants. This method of estimating ground-water discharge was used by G. E. P. Smith in Arizona.

Virginia.—At the request of the water commission of Arlington County, Va., port was prepared by C. P. Ross, of the geologic branch, on ground-water itions in that county. A preliminary study of the ebbing and flowing ngs in the State was made by Mr. Meinzer, and plans were considered for ing a more thorough study of these springs.

Washington.—Work was done by Mr. Bryan on a report on the geology of dam sites at Cle Elum Lake, and a paper by him on the Palouse soil problem with an account of elephant remains was transmitted to the geologic branch for publication.

DIVISION OF QUALITY OF WATER

During the year 560 samples of water were analyzed. Reports were transmitted for publication on the chemical character of water of Pecos River, Tex., the surface waters of New Jersey, and the surface waters and ground waters of Florida. Analyses of 41 samples of surface and ground waters from Rhode Island completed the analytical work for a report on the chemical character of waters of the State. Analyses of 143 samples of water were made for Mr. Hall's report on the ground water of southeastern Pennsylvania. Progress was made on studies of the surface waters of North Carolina and the ground waters of New Jersey. Analyses were made of 90 samples of water from Colorado River and its tributaries, and the quantities of silt in 70 samples were determined.

DIVISION OF POWER RESOURCES

The work of the division of power resources during the year comprised the preparation of monthly reports of the production of electricity and consumption of fuel by public-utility power plants and of a report on the developed water power of the United States.

The monthly reports are based on reports submitted by public-utility companies. About 4,000 power plants, each having a monthly output of 10,000 kilowatt-hours or more, are requested to submit reports of their production of electricity and consumption of fuel. The total capacity of the generators in these plants in March, 1926, was about 23,840,000 kilowatts. Reports received represent about 95 per cent of the total generating capacity of these plants. The following tables show the power and fuel statistics for the calendar years 1919 to 1925:

Electricity produced at public-utility power plants in the United States, 1919-1925

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)
1919.....	38,921,000,000	-----	14,608,000,000	37.5	-----	24,315,000,000	62.5	-----
1920.....	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921.....	40,976,000,000	-5.9	14,971,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922.....	47,659,000,000	+16.3	17,206,000,000	36.1	+14.9	30,453,000,000	63.9	+17.3
1923.....	55,674,000,000	+16.8	19,348,000,000	34.8	+12.4	36,327,000,000	65.2	+19.2
1924.....	59,014,000,000	+6.0	19,999,000,000	33.8	+3.2	39,014,000,000	66.2	+7.2
1925.....	65,870,000,000	+11.6	22,356,000,000	33.9	+11.9	43,514,000,000	66.1	+11.3

Fuel consumed in the production of electricity at public-utility plants in the United States, 1919-1925

Year	Coal		Fuel oil		Gas	
	Short tons	Change from previous year (per cent)	Barrels	Change from previous year (per cent)	M cubic feet	Change from previous year (per cent)
1919	35, 100, 000		11, 050, 000		21, 406, 000	
1920	37, 124, 000	+5.8	13, 123, 000	+18.8	24, 702, 000	+15.4
1921	31, 585, 000	-14.9	12, 045, 000	-8.2	23, 722, 000	-4.0
1922	34, 179, 000	+8.3	13, 197, 000	+9.6	27, 172, 000	+14.6
1923	38, 954, 000	+14.0	14, 679, 000	+11.2	31, 433, 000	+15.7
1924	37, 556, 000	-3.6	16, 680, 000	+13.3	48, 443, 000	+54.1
1925	40, 222, 000	+7.1	10, 246, 000	-38.4	46, 521, 000	-4.0

There has been a marked increase of efficiency in the utilization of coal in the production of electricity by public-utility power plants during the period covered by these power reports. In 1919 the average consumption of coal by such plants in producing 1 kilowatt-hour of electricity was 3.2 pounds; in 1925 it was 2.1 pounds. These figures indicate an increase of more than 50 per cent in efficiency. Moreover, these are only average rates. The best coal-burning plants are now producing a kilowatt-hour of electricity with but 1 pound of coal, and recently power plants using gas and oil for fuel have equaled the performance of coal-burning plants as measured in British thermal units.

Reports on the stock of coal held by electric public-utility power plants were made for inclusion in reports on commercial stocks of coal undertaken by the Bureau of the Census, Department of Commerce, September 1 and November 1, 1925; January 1, February 1, April 1, and July 1, 1926.

DIVISION OF LAND-CLASSIFICATION INVESTIGATIONS

The division of land-classification investigations performed certain technical work required for the classification of public lands with respect to their water resources. The work was done mainly by the use of funds allotted by the conservation branch. The examination of public lands for designation under homestead laws was transferred about the middle of the year to the conservation branch, and the work done during the year will be discussed in the report of that branch. The remaining work of this division comprises the examination of streams and neighboring lands for the classification of public lands with respect to their value for water power and irrigation and the preparation of reports, either for office use or for publication, on the power value of streams. The following statements indicate the work done during the year:

Arizona.—A report begun in 1924 and based on surveys and examinations made in several previous years of the potential water power and storage capacities of the dam sites on Colorado River below the mouth of the Green River was published in October as Water-Supply Paper 556, "Water power and flood control of Colorado River below Green River, Utah."

California.—An engineer was detailed to serve as a member of a committee representing the Departments of Agriculture and the Interior which investigated

and reported on applications of the Los Angeles flood-control district and the city of Pasadena, Calif., for conflicting rights of way for reservoirs in San Gabriel Canyon.

Colorado.—An investigation of the water-power resources of the upper San Juan River, Colo., begun late in the previous year has been completed, and a manuscript report thereon was practically completed at the end of the year. Work has been continued on a report on the utilization of Colorado River in Colorado and Utah to the mouth of Green River. A report has been made for office use on the application of the Denver & Salt Lake Railroad Co. for a right of way for a proposed railroad line between Orestod and Dotsero, referred to as the Dotsero cut-off; also on the power-site value of lands vacated by the Federal Power Commission in connection with the issuance of a license for project No. 149 and proposed for restoration to entry.

Idaho.—A power investigation, begun with a reconnaissance survey in the previous year, of the Payette River Basin, Idaho, in connection with river and dam-site surveys by a topographic party, has been completed, and a report on the power resources, including the classification of lands, is in progress. A report on the power resources of the Clearwater River Basin is nearing completion.

Montana.—A report on water power and irrigation in the Jefferson River Basin, Mont., based on an investigation made in the summer of 1923, has been prepared for publication as a water-supply paper.

Oregon.—A manuscript report was completed on the power resources, including the classification of lands, in the Coquille River Basin, Oreg., based on investigations made in the previous year. A similar report was completed for the Rogue River Basin. An office study of the water supply of streams in east and south-central Oregon has also been completed.

Utah.—An examination of the power value of the canyon section of San Rafael River, Utah, including the supervision of plan and profile surveys of that part of the river, was completed early in the year. A report on this investigation is to be made a part of a report, to be published as a water-supply paper, on the utilization of Green River in Wyoming, Colorado, and Utah, on which work has been continued during the year. A report has been made for office use on the power value of lands in the Uinta Basin; also one on the location of a transmission line of the Beaver River Power Co. and of the conduit of the Pioneer power plant of the Utah Power & Light Co., setting forth whether public lands are occupied in trespass by these companies. At the request of the Federal Power Commission recommendations have been made with respect to stream-gaging requirements to be inserted in licenses for which applications have been made by the Utah Power & Light Co. for certain of its constructed power plants.

Washington.—Work has been continued on river surveys and power investigations of streams draining the Olympic Range, Wash. During the year surveys and office reports have been completed for the North and South Forks of Skokomish River, Hamma Hamma, Dosewallips, and Duckabush Rivers, and Lilliwaup Creek, and surveys have been completed of Wynoochee and Quilcene Rivers.

Wyoming.—At the request of the Federal Power Commission an examination of a project to develop power on East Pine Creek, Wyo., was made and a report giving its results was prepared.

CONSERVATION BRANCH

The conservation branch, created July 1, 1925, by survey order 115, incorporates the functions and personnel of the former land classification branch of the Geological Survey with those of the oil-leasing organization and mineral-leasing division of the Bureau of Mines, which were transferred to the Geological Survey by Interior Department order 54, issued June 25, 1925, in conformity with Executive order of June 4, 1925. Its field of work is coextensive with the public domain of the United States, including Alaska, and with the principal mineral-producing Indian reservations. Its duties include the classification of lands according to

their highest use; the protection of the public interest in undeveloped mineral, water-power, and agricultural resources; and the promotion of economical and efficient development of mineral deposits on public and Indian land.

ORGANIZATION AND PERSONNEL

At the end of the fiscal year the organization and technical personnel of the conservation branch in the District of Columbia were as follows:

Chief, Herman Stabler.

Assistant chief, J. D. Northrop.

Consulting mining engineer, H. I. Smith.

Consulting hydraulic engineer, W. G. Hoyt.

Consulting petroleum engineer, H. V. Moffat.

Attorney, G. W. Holland.

Chief clerk, Elsie Patterson.

Principal clerk, field operations, W. A. Kearney.

Mineral-classification division: J. D. Northrop, geologist, chief; C. D. Avery and N. F. Stull, geologists.

Power division: B. E. Jones, hydraulic engineer, chief; J. G. Mathers and N. J. Tubbs, hydraulic engineers; R. O. Holland, classifier.

Homestead division: A. E. Aldous, classifier, chief; J. F. Deeds and C. E. Nordeen, hydraulic engineers; L. R. Brooks, Depue Falck, E. R. Greenslet, W. L. Hopper, G. M. Kerr, R. E. Morgan, J. Q. Peterson, and O. D. Stanton, classifiers.

Mineral-leasing division: H. I. Smith, mining engineer, chief; P. G. Elder, mining engineer; H. V. Moffat and R. D. Ferguson, petroleum engineers; F. R. Parsons, oil and gas accountant.

In addition, two hydraulic engineers, R. W. Davenport and D. J. Guy, were detailed from the branch for duty with the Federal Power Commission.

During the fiscal year there were 74 separations, including 1 death, 22 resignations, 10 transfers, and 41 terminations by reason of discontinuance of work; and 25 appointments were made. On June 30, 1926, the personnel of the branch, both office and field, numbered 137, consisting of 1 chief classification engineer, 1 attorney, 4 geologists, 8 hydraulic engineers, 11 mining engineers, 29 petroleum and natural-gas engineers, 10 classifiers, 1 chemist, 10 draftsmen, 6 oil gagers, 3 accountants, 49 clerks, 1 mechanic, and 3 janitors. Of these 81 are professional and subprofessional, employees and 56 are clerical.

FUNDS

The funds available for the work of the conservation branch for the fiscal year were as follows:

Classification of lands.....	\$265,000
Supervision of oil and gas operations.....	240,630
Supervision of mining operations.....	86,920
Supervision of naval-reserve development.....	50,000
	<hr/>
	642,550

CORRESPONDENCE

During the year 24,606 letters were received in the Washington office of the conservation branch. In addition, about 26,500 pieces of miscellaneous correspondence were received in the branch for its

information, transmittal to the appropriate field office, or filing. These figures show an increase of 28,613 pieces, or 127 per cent, in incoming correspondence over the fiscal year 1925, when the branch did not include the mineral-leasing work. Within the same period 19,787 letters and reports were prepared and sent out, an increase of 7,151 pieces, or 57 per cent, in outgoing correspondence compared with 1925. In addition, about 5,550 pieces of miscellaneous correspondence were sent out by the branch during the year.

SUMMARY OF LAND-CLASSIFICATION CASES

The activities of the conservation branch with respect to land classification include the preparation of reports in response to requests for data or action on specific cases, the preparation of orders of withdrawal and restoration of lands not involved in specific requests, and the promulgation of broad areal classifications. To the extent that these types of activity are subject to expression in terms of acreage and number of cases acted on the work of the branch is indicated in the following summary and in the tables accompanying the report of each division. The first table summarizes activity with respect to requests for data or action on specific cases, and the terms "gain" and "loss" signify, respectively, decrease and increase in the number of cases pending.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1925-26						Record since receipt of first case	
	Pending July 1, 1925	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1926	Gain or loss during fiscal year	Received	Acted on
General Land Office requests:								
General.....	135	979	1,114	888	226	-91		
Time extensions.....		334	334	288	46	-46	334	288
Oil development.....	123	827	950	689	261	-138	1,817	1,556
Applications for classification as to mineral:								
Coal.....	3	5	8	3	5	-2	3	3
Oil.....	84	1,102	1,186	898	288	-204	5,454	5,166
Phosphate.....							35	35
Applications for mineral permits.....	303	5,731	6,034	5,612	422	-119	38,404	37,982
Applications for mineral leases.....	14	143	157	134	23	-9	994	971
Applications for patent, potassium.....		55	55	55			123	123
Federal Power Commission cases:								
Preliminary permits.....	3	5	8	2	6	-3	56	50
Licenses.....	1	10	11		11	-10	22	11
Determinations under section 24.....	7	40	47	36	11	-4	128	117
Applications for reclassification as to water resources:								
Applications for rights of way.....	3	19	22	16	6	-3	657	651
Irrigation project reports.....	29	175	204	167	37	-8	5,796	5,789
Applications under enlarged-homestead acts.....	6	3	9	9		+6	892	892
Applications under stock-raising homestead act.....	195	346	541	395	146	+49	55,739	55,593
Applications under ground-water reclamation act.....	1,429	2,960	4,389	3,117	1,272	+157	115,545	114,273
Indian Office requests for information.....	27	25	52	32	20	+7	829	800
Cases in national forests.....	1	7	8	6	2	-1	9,502	9,500
		6	6	4	2	-2	305	303
	2,363	12,772	15,135	12,351	2,784	-421		

MINERAL-CLASSIFICATION DIVISION

The work of the mineral-classification division involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, chiefly through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation. The results of its work take the form of mineral classifications, of orders of withdrawal, modification, and restoration, and of reports concerning the mineral character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public land and Indian land laws.

Because of small personnel and the volume and pressure of demands in connection with the administration of the mineral leasing laws, the branch made little headway during the year in classifying the vast areas throughout the West that are still embraced in mineral withdrawals. The results accomplished include, however, net decreases of 318,754 acres in the total area of outstanding coal withdrawals, of 137,904 acres in the total area of outstanding petroleum withdrawals, and of 480 acres in the total area heretofore classified as oil-shale land. Phosphate withdrawals were increased 160 acres, in Florida, and potash withdrawals were increased 7,418,437 acres, in New Mexico.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications June 30, 1926, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash
	With- drawn	Classi- fied as coal land	With- drawn	Classi- fied as oil land	With- drawn	Classi- fied as oil shale land	With- drawn	Classi- fied as phos- phate land	With- drawn
Alaska.....		56,993							
Arizona.....	139,415		92,496						
Arkansas.....		61,160							
California.....	17,603	8,720	1,178,392						90,518
Colorado.....	4,241,477	3,174,422	218,997		64,560	952,239			
Florida.....							84,522	120	
Idaho.....	4,761	4,603					396,612	268,299	
Louisiana.....			466,990	4,191					
Montana.....	8,160,273	8,418,643	1,350,426	67,651			279,944	3,833	
Nevada.....	83,673				123				39,422
New Mexico.....	5,157,782	568,084							7,418,437
North Dakota.....	5,954,364	11,178,286	84,894						
Oregon.....	4,361	18,887							
South Dakota.....		250,093							
Utah.....	3,742,760	1,252,589	1,870,627		91,464	2,703,755	301,945	160	
Washington.....	691,801	141,444							
Wyoming.....	2,347,039	6,740,907	545,737			460,103	992,969	25,293	
	30,545,315	31,874,831	5,808,559	71,842	156,147	4,116,097	2,055,992	297,705	7,548,377

Since February, 1920, the principal activity of the mineral-classification division has been connected with the administration of the mineral-leasing laws—that is, the Alaskan coal-leasing law, the potash-leasing law, and the general mineral-leasing law. Every application for a prospecting permit or lease under any of these laws is carefully scrutinized, and a report is made to the Commissioner of the General Land Office or the Secretary of the Interior on the geologic conditions involved. Applications for coal permits require a determination of the necessity for prospecting any or all of the land sought. Applications for coal leases entail a division of the area sought into logical operating or leasing units consistent in area and content of coal with the scale of mining operations proposed and the recommendation of appropriate requirements as to royalty, minimum investment, and minimum annual production. Applications for oil and gas prospecting permits require a determination of the structural relations of the land sought with respect to those of other permit and lease holdings of the applicant elsewhere in the same State and with respect to the known geologic structure of any producing oil or gas field and, if in conflict with an unperfected entry under the nonmineral-land laws, classification as to the prospective oil and gas value of the entered land. Applications for oil and gas leases involve a determination of the validity and sufficiency of the oil or gas discovery alleged and a recommendation of appropriate royalty requirements. Applications for sodium permits or leases, potassium permits, leases, or patents, and oil-shale leases entail generally similar determinations and recommendations.

The following table summarizes the results of the year's work to the extent that they involve specific applications for permit, lease, or patent rights under the leasing laws:

Applications received, acted on, and pending under the mineral-leasing acts, fiscal year 1925-26

Mineral	Permits			Leases			Patents		
	Re- ceived	Acted on	Pend- ing	Re- ceived	Acted on	Pend- ing	Re- ceived	Acted on	Pend- ing
Oil and gas.....	5,321	5,136	397	29	23	7			
Coal.....	167	166	16	93	90	15			
Phosphate.....				2	2				
Sodium.....	19	18	2	1		1			
Potassium.....	224	292	7	16	17		55	55	
Oil shale.....				2	2				

In addition to the work summarized, the division determines and defines the limits of the "known geologic structure" of producing oil and gas fields and reports on the structural relations of lands involved in proposed assignments of leases or permits, on the status and structural significance of drilling on or adjacent to lands involved in permit relinquishments or cancellations, on the feasibility of permit and lease consolidations, on the propriety of time extensions based on alleged contributions to drilling on lands other than those described in the permit of the contributor, and on the beneficial

or adverse effects on present or future mineral development of all applications for rights of way across withdrawn, classified, or defined public lands.

During the fiscal year 1925-26 definitions of the "known geologic structure" of the Artesia field, N. Mex., and the Hatfield, Mahoney, Rex, East Ferris, and West Ferris fields, Wyo., were promulgated, together with revisions of the outstanding definition of the Woodside field, Utah; and the Kevin-Sunburst, Gas Ridge, and Shelby fields, Mont.; and cancellation of the definition of the White River field, Colo., promulgated in 1922. The net area included in outstanding definitions of "known geologic structure" of producing oil and gas fields on June 30, 1926, was 531,720 acres, in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Other phases of division activity include the scrutiny of all enlarged and stock-raising homestead designations for the elimination of any lands within the limits of defined or producing oil or gas structures and the preparation of reports at the request of the General Land Office and the Office of Indian Affairs on the mineral possibilities of lands sought under certain of the nonmineral-land laws.

In order to facilitate the solution of mineral-leasing problems, Geologist W. W. Boyer was assigned to permanent headquarters in Denver, Colo., from which field investigations of specified lands are made to satisfy urgent requirements of the division.

The larger items of geologic field work undertaken by the geologic branch but financed largely by the conservation branch during 1926 include (1) areal examinations in Routt and Moffat Counties, Colo.; in Carbon and Sweetwater Counties, Wyo.; and in Carbon, Emery, Grand, and San Juan Counties, Utah; (2) coal investigations in Grand, Sevier, and Sanpete Counties, Utah; and in Garfield, Mesa, Montrose, and San Miguel Counties, Colo.; (3) potash investigations in Tooele and Box Elder Counties, Utah, and in Esmeralda County, Nev.; (4) phosphate investigations in southwestern Montana and southeastern Idaho; and (5) oil and gas investigations in the Kevin-Sunburst and Bowdoin districts, Mont.; in the Black Hills region, S. Dak.; in Kern, Monterey, and Humboldt Counties, Calif.; and in the Artesia district, N. Mex.

POWER DIVISION

The work of the power division consists primarily in obtaining and making available for use in the administration of the public-land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public-land laws. An endeavor is made to determine the proper administrative action by which the possibility of power development may be preserved with minimum interference with agricultural, transportation, or other interests. In the course of this work a review of all power reserves is carried on, in order that all land having primary value for the development of power, and only such land, shall be reserved for that purpose. The extent of this task is indicated by the fact that areas aggregating more than 5,000,000 acres are now included in

power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches of the Geological Survey. The larger field projects undertaken during the year at the request and expense of the conservation branch to obtain information for power classification include plan and profile surveys and power-site and reservoir-site investigations on (1) South Fork of Payette River and in Bear Valley and the Stanley Basin, Salmon River drainage basin, Idaho; (2) North and South Forks of Stiloguamish River, Skokomish, Lilliwaup, Hamma Hamma, and Dosewallips Rivers, Wash.; (3) McKenzie, Siletz, North Fork of Coquille, and Crooked Rivers, Oreg.; (4) Eel River, Calif.; (5) San Rafael River, Utah; (6) San Juan River and tributaries, Colo. and N. Mex. Studies were continued leading to the preparation of reports for publication on water utilization on Green and upper Colorado Rivers in Colorado, Utah, and Wyoming.

The information obtained is indexed and incorporated in an inventory of water resources, which, when complete, will enable the Geological Survey to give competent advice on short notice as to the manner in which each tract of public land having value for power can best be used in connection with the development of water power and as to the relation of such use to other possible uses of the tract. Copies of many of the reports on the power possibilities of the streams examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press.

The work of the division is briefly summarized in the accompanying tables, showing power-site reserves and outstanding water resources, withdrawals, and classifications, and in the general summary of cases involving land classification (p. 74).

Pursuant to instructions of the Secretary of the Interior, dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted by the Secretary since January 1, 1913, were called upon for detailed reports of the operation or development of their power systems during the calendar year 1925. The total installation of the reporting companies is 1,950,000 kilowatts, of which 1,510,000 kilowatts is installed at hydraulic plants. The total energy generated amounted to 6,980,000,000 kilowatt-hours, of which more than 6,000,000,000 kilowatt-hours was generated by water power.

Power output of permittees and grantees, 1916-1925

Year	Kilowatt-hours	Increase or decrease		Year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1916.....	1,200,000,000			1921.....	3,725,000,000	-475,000,000	-11
1917.....	2,000,000,000	+800,000,000	+67	1922.....	4,947,000,000	+1,222,000,000	+33
1918.....	3,200,000,000	+1,200,000,000	+60	1923.....	5,910,000,000	+963,000,000	+19
1919.....	3,100,000,000	-100,000,000	-3	1924.....	6,100,000,000	+184,000,000	+3
1920.....	4,300,000,000	+1,100,000,000	+35	1925.....	6,980,000,000	+880,000,000	+14

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat., 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1925	Eliminated prior to July 1, 1925	Reserves outstanding prior to July 1, 1925	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1926
Alabama	785		785	1,592		2,377
Alaska	211,220	530	210,700	2,426		213,126
Arizona	1,263,798	113,194	1,150,601	6,600	1,150	1,156,051
Arkansas	28,551		28,551			28,551
California	1,033,500	25,582	1,007,918	137,117	2,907	1,142,128
Colorado	479,684	70,509	409,125	27,464	5,274	431,315
Florida	486		486			486
Idaho	451,894	186,220	265,174	16,413	80	281,507
Michigan	1,240		1,240			1,240
Minnesota	13,299	532	12,767	5,773		18,530
Mississippi				3		3
Montana	302,667	93,779	208,888	922	600	209,210
Nebraska	761		761			761
Nevada	300,750	480	300,270	48		300,318
New Mexico	270,578	7,633	263,245		81	263,164
Oregon	577,693	85,648	492,045	76,744	24,669	544,120
South Dakota	12		12			12
Utah	671,985	123,114	548,281	74,859	320	622,820
Washington	249,032	52,810	196,222	43,585		239,807
Wisconsin	1,210	226	984			984
Wyoming	222,543	73,408	149,135	17		149,152
	6,080,835	833,655	5,247,180	393,563	35,081	5,605,662

Summary of outstanding water resources withdrawals and classifications June 30, 1926, in acres

State	Power reserves					Reservoir with- drawals	Public water with- drawals	Ground- water reclama- tion des- ignations
	With- drawals	Classi- fications	Design- ations *	Miscel- laneous	Total			
Alabama	120	1,735		522	2,377			
Alaska	93,415	43,005		76,706	213,126			
Arizona	394,139	37,182	528,239	196,491	1,156,051	23,040	15,280	
Arkansas	22,354	1,590		4,607	28,551			
California	289,073	173,484		679,571	1,142,128	1,160	167,551	
Colorado	231,910	164,317		35,088	431,315	1,728	2,220	
Florida				486	486			
Idaho	210,866	63,556		7,095	281,507		13,185	
Michigan	1,240				1,240			
Minnesota	12,309			6,221	18,530			
Mississippi				3	3			
Montana	131,944	53,409		23,857	209,210	9,080	8,097	
Nebraska	761			761	761			
Nevada	27,492	27,786		245,040	300,318		6,946	1,559,255
New Mexico	120,008		143,161		263,164		8,956	
North Dakota						1,669		
Oregon	374,188	95,835	15,731	58,366	544,120	10,619	20,181	
South Dakota				12	12		240	
Utah	444,688	153,766		24,366	622,820	80	33,475	
Washington	97,751	81,395		60,661	239,807	35,943	920	
Wisconsin				984	984			
Wyoming	82,829	25,621		40,702	149,152	1,714	79,905	
	2,585,072	922,681	687,131	1,460,778	5,605,662	84,933	356,956	1,559,255

* Designated and not otherwise withdrawn.

HOMESTEAD DIVISION

The homestead division of the conservation branch incorporates the personnel and functions of the division of homestead classification and the irrigation section of the division of hydrographic

classification of the former land-classification branch with those of the division of land-classification investigations of the water-resources branch.

The functions of the reorganized division consist of the classification of lands under the enlarged-homestead law as nonirrigable; the classification of lands under the Nevada ground-water reclamation act as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public-land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; and the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family.

Applications for classification are disposed of in accordance with the results of field examinations by members of the division and with information obtained from other sources. Applications in some regions lead to the planning and execution of broad field studies that result in the classification of large areas and provide in advance the basis for appropriate action on new applications.

The number of cases received and acted on during the fiscal year is shown in the general summary of cases (p. 74). In the field broad areal studies were made in the northern Great Plains region and also in Colorado, Idaho, Nevada, Utah, and Washington. The work in Nevada included a reconnaissance investigation to determine the agricultural utility of the unreserved public land throughout the State. Detailed examination of lands embraced in specific applications for designation under the enlarged and stock-raising homestead laws was continued in all the public-land States west of the 100th meridian.

Substantial progress was made on the report, begun in 1925 in cooperation with the Department of Agriculture, on agriculture and land utilization in the northern Great Plains region, the remaining four of eight atlas sheets showing land classification in that region being completed during the year. Authorization was given by the Secretary of the Interior for the extension of this cooperation to include the preparation of similar classification maps for the central Great Plains region, and some preliminary field work on this project was done incidental to other work in the region.

During the year the area designated under the Nevada ground-water reclamation act, as a result of the work of the division, was increased from 1,550,420 to 1,559,255 acres. Outstanding withdrawals, aggregating 11,530 acres, under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

Summary of enlarged-homestead designations, in acres

[Areas classified as arid and nonirrigable, residence by entrymen required (acts of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; June 17, 1910 (36 Stat. 531), applicable to Idaho; June 13, 1912 (37 Stat. 132), applicable to California; North Dakota; Mar. 3, 1915 (38 Stat. 953), applicable to Kansas; Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (acts of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; June 17, 1910 (36 Stat. 531), applicable to Idaho)]

State	Designations prior to July 1, 1925	Cancellations prior to July 1, 1925	Designations outstanding prior to July 1, 1925	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1925
Arizona.....	31,400,664	5,429,754	25,970,910	20,835	441,120	25,550,625
California.....	13,187,333	238,453	12,948,880	68,447		13,017,327
Colorado.....	33,580,721	195,508	33,385,213	102,031		33,487,244
Idaho:						
Total.....	13,603,838	400,885	13,142,953	66,886	40	13,209,799
Nonresidence.....	572,747	4,233	568,514			568,514
Kansas.....	647,914		647,914	2,170		650,084
Montana.....	53,345,205	245,728	53,099,477	70,401		53,169,878
Nevada.....	50,120,150	3,504,797	46,555,353	46,170	15,920	46,585,603
New Mexico.....	43,726,225	227,732	43,498,493	45,955		43,544,448
North Dakota.....	12,274,012	3,848	12,270,164	2,737		12,272,901
Oregon.....	21,256,324	969,902	20,286,422	17,130		20,283,552
South Dakota.....	16,333,811	348,170	15,985,641	2,285		15,987,926
Utah:						
Total.....	11,415,634	408,609	11,007,025	119,760	52,315	11,074,470
Nonresidence.....	1,640,094	28,280	1,611,814	5,875	50,320	1,567,369
Washington.....	6,646,592	251,842	6,394,750	3,350		6,398,100
Wyoming.....	29,411,041	161,764	29,249,277	136,860	279	29,385,856
	336,949,464	12,526,992	324,422,472	705,017	509,674	324,617,815

* Includes 8,395 acres previously designated under secs. 1-5, now designated under sec. 6.

Summary of stock-raising homestead designations, in acres

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family. Act of December 29, 1916 (39 Stat. 862)]

State	Designations prior to July 1, 1925	Cancellations prior to July 1, 1925	Designations outstanding prior to July 1, 1925	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1925
Arizona.....	13,896,363	551,720	13,044,663	50,714	35,960	13,059,517
Arkansas.....	1,120		1,120			1,120
California.....	7,720,392	760	7,719,632	91,917	640	7,810,909
Colorado.....	8,152,040	18,720	8,133,320	203,896	120	8,337,096
Florida.....	480		480			480
Idaho.....	5,262,682	1,774	3,260,908	104,982	80	3,365,810
Kansas.....	113,499		113,499	640		114,139
Michigan.....	3,451		3,451			3,451
Montana.....	15,023,286	17,081	15,006,205	183,004		15,189,209
Nebraska.....	193,494		183,494	6,080		189,574
Nevada.....	498,548	2,800	495,748	21,585	320	517,013
New Mexico.....	31,139,754	636	31,139,118	39,498		31,178,616
North Dakota.....	364,855		364,855	11,037		375,892
Oklahoma.....	76,260		76,260	3,765		80,025
Oregon.....	6,216,412	2,488	6,213,924	35,995	640	6,249,279
South Dakota.....	6,468,914	550	6,468,364	16,519		6,484,883
Utah.....	1,350,587	860	1,349,707	137,060		1,486,767
Washington.....	673,745	1,134	672,611	8,876		681,487
Wyoming.....	19,813,988	5,054	19,808,934	125,764	1,159	19,933,539
	116,959,890	904,077	116,055,813	1,041,352	38,819	117,058,346

Additions during the year to public water reserves included 495 acres in Arizona, 40 acres in California, 56 acres in Colorado, 990 acres in Idaho, 720 acres in Nevada, 640 acres in New Mexico, 2,400 acres in Oregon, and 125 acres in Utah. Eliminations from such reserves aggregated 11 acres in Arizona, 80 acres in Idaho, 2,740 acres in Nevada, and 760 acres in Wyoming. Outstanding withdrawals of public land for stock watering are tabulated in the summary of water-resources withdrawals and classifications (p. 79).

By blanket order of withdrawal creating Public Water Reserve No. 107, which received Executive approval April 17, 1926, every smallest legal subdivision of the public-land surveys which is vacant unappropriated public land and contains a spring or water hole and all land within a quarter of a mile of every spring or water hole located on unsurveyed public land was reserved for public use and in aid of pending legislation. This order obviates the necessity for future withdrawals of specific tracts valuable for stock watering but requires a determination by the division with respect to all entries of public land whether or not any of the subdivisions involved are in fact affected by it.

MINERAL-LEASING DIVISION

The mineral-leasing division of the conservation branch incorporates the records, personnel, and functions relating to mineral leasing of the petroleum division and mineral-leasing division of the Bureau of Mines, which were transferred to the Geological Survey July 1, 1925.

The work of this division is supervisory (both inspectional and regulatory) with respect to operations for the discovery and development of petroleum, natural gas, oil shale, coal, phosphate, sodium, and potassium on public lands, of petroleum and natural gas on naval petroleum reserves, and of a variety of minerals on Indian lands. This work is carried on with a minimum of administrative supervision from Washington through district offices and suboffices at or near the primary centers of mining or drilling activity, under the direction of responsible district engineers who have full authority to represent the Government within their jurisdiction and to enforce compliance with the law and regulations under which operations are conducted.

The district offices and suboffices and the engineers in charge June 30, 1926, are as follows:

Oil and gas operations:

Rocky Mountain district, Casper, Wyo., J. W. Steele, supervisor;

D. P. Wardwell, deputy supervisor. Suboffices as follows:

Midwest, Wyo., R. O. Armstrong, engineer in charge.

Fort Washakie, Wyo., L. S. Miller, engineer in charge.

Billings, Mont., J. R. Reeve, engineer in charge.

Shelby, Mont., E. A. Hanson, engineer in charge.

Denver, Colo., B. H. Carnahan, engineer in charge.

Shiprock, N. Mex., J. H. Hassheider, engineer in charge.

Roswell, N. Mex., J. C. Miller, engineer in charge.

Pacific district, Taft, Calif., R. C. Patterson, supervisor; J. M. Alden, deputy supervisor.

Mid-Continent district, Muskogee, Okla., H. J. Lowe, supervisor.

Suboffices as follows:

Guthrie, Okla., H. B. Soyster, engineer in charge.

Ardmore, Okla., H. W. Shaner, engineer in charge.

Mining operations:

Denver, Colo., C. L. Duer, mining supervisor.

Billings, Mont., R. H. Allport, mining supervisor.

Salt Lake City, Utah, B. W. Dyer, mining supervisor.

McAlester, Okla., W. W. Fleming, mining supervisor.

Miami, Okla., C. F. Williams, mining supervisor.

At the beginning of the fiscal year the personnel of the mineral-leasing division numbered 138; at its end 89. Most of the decrease is due to separations resulting from termination of the period of Government operation of the Red River oil field, Oklahoma, 1925.

December 1, 1925, and the return of the producing properties to their owners in accordance with awards by the Secretary of the Interior under the Red River relief act of March 4, 1923 (42 Stat. 1448). The remainder is due to the discontinuance of certain lines of research; to the discontinuance of suboffices at Shreveport, La.; Wichita Falls, Tex.; and Laramie, Wyo.; to the consolidation of the suboffice at Winnett, Mont., with that at Billings, Mont.; and to distribution among other employees, in such manner as to obviate for the time being the making of new appointments, of the duties of certain employees who resigned. The activities of the suboffice formerly at Shreveport, La., were transferred to the district office at Muskogee, Okla.; the supervisory activities of the office at Wichita Falls, Tex., were transferred to Ardmore, Okla.; those of the suboffice at Laramie, Wyo., to the district office at Casper, Wyo. A new suboffice was established during the year at Roswell, N. Mex., and the suboffice formerly at White Eagle, Okla., was transferred to Guthrie, Okla.

ACTIVITIES ON THE PUBLIC DOMAIN

The supervisory work of the mineral-leasing division on lands involving publicly owned mineral deposits was increased during the year by the receipt of notification of the issuance of prospecting permits, leases, and licenses as follows: Oil and gas permits, 3,891; oil and gas leases, 45; coal permits, 108; coal leases, 32; coal licenses, 79; potassium permits, 29; potassium lease, 1; sodium permits, 12; sodium lease, 1; phosphate lease, 1; oil-shale lease, 1; a total of 4,200.

The following tables show, by States and by minerals, the total number of prospecting permits, leases, and licenses involving public land issued and the number under supervision at the end of the fiscal year, together with important data relative thereto:

Mineral leases, licenses, and permits issued by the Secretary of the Interior and notification received by the Geological Survey up to June 30, 1926

State	Coal *			Potash *		Sodium *		Oil shale, leases*	Phosphate, leases*	Oil and gas *	
	Permits	Leases	Licenses	Permits	Leases	Permits	Leases			Permits	Leases
Alabama.....		1									
Arizona.....	2			7						783	
Arkansas.....	1									2	
California.....	12			68	17	5				2,856	145
Colorado.....	171	66	16	4						2,817	7
Idaho.....	19			1					2	192	
Kansas.....										5	
Louisiana.....										37	8
Michigan.....									1	1	
Mississippi.....										11	
Montana.....	91	49	4	2						3,128	34
Nebraska.....				4						12	
Nevada.....	41			75		37	1			940	
New Mexico.....	108	10		17		4	1			2,966	
North Dakota.....	11	30	2			5				29	
Oklahoma.....										54	16
Oregon.....	35	2		1		1		1		53	
South Dakota.....	5	1	1							147	
Utah.....	104	48	2	325						3,192	
Washington.....	46	2				2				63	
Wyoming.....	169	36	15		1	1		1		4,714	263
	815	245	40	504	18	55	1	2	2	22,002	465
Alaska.....	33	11	72							1,046	

* Act of Feb. 25, 1920.

* Act of Oct. 2, 1917.

* Act of Mar. 4, 1921.

* Act of Oct. 20, 1914.

Required investment and total acreage: Act of Feb. 25, 1920, \$9,928,670, 2,181,665.48 acres; act of Oct. 2, 1917, \$2,715,470, 1,154,736.54 acres; acts of Mar. 4, 1921, and Oct. 20, 1914 (Alaska), \$1,204,000, 69,458.15 acres.

Mineral leases, licenses, and permits under supervision on public lands and naval petroleum reserves June 30, 1926

State	Coal						Oil and gas	
	Leases		Permits		Licenses		Per- mits (num- ber)	Leases (number)
	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres		
Alaska.....	9	9,877.28	23	38,875.01	1	10.00	980	
Alabama.....	1	1,840.00						
Arizona.....							621	
Arkansas.....							2	
California.....			4	2,365.98			2,492	134
Colorado.....	63	11,682.83	20	11,858.60	8	320.08	2,600	5
Idaho.....			6	7,597.96			172	
Kansas.....							5	
Louisiana.....							32	2
Michigan.....							1	
Mississippi.....							3	
Montana.....	44	6,011.34	13	5,264.59	1	40.00	2,962	34
Nebraska.....							10	
Nevada.....			3	6,001.21			845	
New Mexico.....	8	1,121.10	46	69,543.72			2,760	
North Dakota.....	28	4,104.75	3	800.00	1	40.00	28	
Oklahoma.....							52	16
Oregon.....	2	2,095.24	4	2,960.00			52	
South Dakota.....	1	79.04					105	
Utah.....	40	35,898.71	38	32,717.25	1	40.00	3,090	
Washington.....	1	600.00	4	2,117.00			54	
Wyoming.....	34	15,199.92	22	14,440.79	2	80.00	4,477	253
	231	88,510.21	186	194,540.11	14	530.08	21,343	444

State	Sodium				Potash			
	Permits		Leases		Permits		Leases	
	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres
Arizona.....					3	7,690.00		
California.....					1	1,639.21	5	9,423.76
Colorado.....					1	2,560.00		
Nevada.....	11	25,320.00	1	1,440.00	5	5,561.32		
New Mexico.....	1	2,560.00			7	16,000.00		
North Dakota.....	3	520.00						
Oregon.....	1	920.00						
Utah.....					23	46,080.00		
Washington.....	2	766.30						
Wyoming.....	1	80.00						
	19	30,166.30	1	1,440.00	40	79,520.53	5	9,423.76

Also Idaho 2 phosphate leases, 1,700 acres; Oregon 1 oil-shale lease, 2,680 acres.

With respect to oil and gas operations the duties of this division include the periodic inspection of properties under development with a view to preventing waste of oil and gas, damage to productive oil, gas, and water "sands," coal beds, and other valuable mineral deposits, and injury to life or property; the approval of well locations and of plans for drilling, setting casing, testing water shut-off, testing for production, shooting, perforating or altering casing, redrilling or repairing and abandonment of wells; the witnessing of as many of these operations as feasible; the testing or witnessing of tests of

natural gas for gasoline content; the issuance of receipts for royalty oil delivered to the Government account and the approval of orders authorizing pipe-line companies to receive oil or gas from Government leaseholds; the determination of royalties due and payable to the Government; and the custody of records and reports pertaining to oil, gas, or gasoline operations and production on public land. With respect to mining operations involving publicly owned deposits of coal, phosphate, sodium, potassium, and oil shale comparable functions are performed. All inspectional and regulatory work of the division is supplemented by informal advice and assistance to lessees in the solution of technical and engineering problems connected with their activities.

An abnormal activity of the division was ended on November 30, 1925, when Federal operation of the Red River oil fields, begun on April 1, 1920, under Federal receivership and continued after June 30, 1924, under the Secretary of the Interior, was brought to a successful conclusion, and the operating properties and profits were turned over to lessees in pursuance of an award made by the Secretary on September 1, 1925. Under the receiver 2,274,634.23 barrels of oil with associated gas was produced and disposed of at a profit, after payment of Government royalties as well as all other expenses, of \$1,983,016.13, or \$0.87 a barrel. Under the Secretary of the Interior 310,975.23 barrels of oil with associated gas was produced and disposed of at a net profit of \$388,826.48, or \$1.25 a barrel. The receivership period was one of drilling wells and flush production. The operations under the Secretary of the Interior began after drilling was substantially complete and involved no flush production. It is felt that unit operation of this field by the mineral-leasing division was a distinct success, the potentialities of the field having been well maintained while a material profit was being made. The field is now under diversified control, but the principles of unit operation are still largely being practiced.

PRODUCTION

Statistics relating to the production of petroleum, natural gas, natural-gas gasoline, and coal under Government lease, permit, and license involving public land are summarized in the following tables:

Petroleum produced from public lands

Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value	Royalty gas	Royalty gasoline
1920-21	5,789,803.48	1,025,965.19	\$1,939,963.68	\$23,678.33	\$5,998.91
1921-22	14,352,826.24	2,568,964.02	3,320,891.86	36,906.24	12,864.46
1922-23	28,443,357.80	5,466,171.00	8,071,051.30	121,885.01	59,834.26
1923-24	39,437,658.44	7,872,073.04	12,033,294.00	88,565.13	70,355.38
1924-25	30,310,308.05	4,951,024.27	7,873,233.63	77,515.59	102,149.69
1925-26	29,712,876.16	4,431,563.63	7,961,665.52	93,506.29	154,265.43
	148,046,830.17	26,315,781.15	40,890,159.99	492,051.59	405,463.13

Petroleum produced from public lands, by States

	Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value
California.....	1920-21	2,201,116.28	311,570.19	\$573,266.63
	1921-22	3,739,448.30	616,491.09	792,444.87
	1922-23	4,666,523.03	674,899.86	619,391.36
	1923-24	4,702,623.55	620,170.36	561,064.90
	1924-25	6,978,882.39	874,515.54	1,033,142.91
	1925-26	6,467,196.06	916,301.77	983,952.57
	-----	26,755,789.61	4,013,948.81	4,563,263.24
Colorado.....	1921-22	36.00	7.20	10.06
	1922-23	272.67	54.52	57.47
	1923-24	17,730.06	3,391.14	2,973.47
	1924-25	409,067.34	32,758.60	36,750.75
	1925-26	825,180.92	44,601.98	64,287.99
	-----	1,262,277.01	80,803.44	104,079.76
Louisiana.....	1920-21	2,716.00	221.02	583.62
	1921-22	1,970.36	92.34	121.69
	1922-23	(*)	(*)	(*)
	1923-24	(*)	(*)	(*)
	1924-25	2,370.60	283.82	472.87
	1925-26	2,080.52	261.20	553.26
	-----	9,046.48	838.38	1,741.53
Montana.....	1920-21	169,634.63	9,385.64	15,406.07
	1921-22	1,635,775.75	70,442.66	185,157.56
	1922-23	2,067,446.93	153,011.71	293,978.83
	1923-24	1,496,303.77	91,885.19	202,765.36
	1924-25	1,510,356.21	83,398.60	160,294.56
	1925-26	2,332,851.97	148,370.26	332,421.63
	-----	9,112,369.26	556,490.05	1,190,024.61
New Mexico.....	1925-26	15,902.58	2,211.70	3,609.13
Oklahoma.....	1925-26	112,160.75	17,351.41	44,253.24
Utah.....	1925-26	2,496.41	499.29	499.29
Wyoming.....	1920-21	3,416,336.57	704,808.34	1,350,707.36
	1921-22	9,075,595.83	1,881,929.73	2,943,147.36
	1922-23	21,709,115.17	4,638,204.91	7,157,623.64
	1923-24	33,221,001.04	7,156,626.85	11,866,490.27
	1924-25	21,409,741.51	3,960,082.71	6,342,632.24
	1925-26	19,954,997.95	3,301,966.03	6,521,988.32
	-----	108,786,788.07	21,643,618.07	34,982,589.19
Grand total.....	-----	148,046,830.17	26,315,781.15	40,890,159.99

* No production.

Coal produced from public lands, in tons

State	1920-21	1921-22	1922-23	1923-24	1924-25	1925-26
Alaska.....	* 65,000.00	86,651.79	116,105.99	88,645.82	99,103.83	98,144.74
Alabama.....						10,066.00
Colorado.....	540.90	52,613.27	219,627.24	257,294.46	297,795.51	353,433.61
Montana.....	100.00	2,046.44	9,575.05	22,317.19	218,934.90	198,602.15
New Mexico.....		8,265.18	19,654.38	28,150.14	18,367.56	37,461.86
North Dakota.....	378.00	33,507.50	123,711.79	168,642.90	127,455.19	163,533.79
Oregon.....				51.20	637.77	638.88
South Dakota.....			586.75	427.50	828.38	1,074.00
Utah.....		26,158.08	103,676.44	218,439.96	139,029.14	172,433.76
Washington.....		26,565.05	60,284.64	52,757.66	25,673.08	16,910.39
Wyoming.....	226,091.70	314,016.10	445,775.49	645,379.44	857,836.30	962,460.51
	292,110.60	548,713.41	1,098,997.77	1,482,106.27	1,785,751.66	2,014,799.19

* Estimated.

ACTIVITIES ON NAVAL PETROLEUM RESERVES

On behalf of the Bureau of Engineering, Department of the Navy, the duties and activities of the mineral-leasing division include supervision, similar to that exercised over oil and gas operations on public lands, over Naval Petroleum Reserves Nos. 1 and 2, in California, and No. 3, in Wyoming. Statistics of the production of petroleum, natural gas, and natural-gas gasoline from naval petroleum reserves are summarized below:

Petroleum produced from naval petroleum reserves

Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value	Royalty gas	Royalty gasoline
1920-21-----	1,614,448.12	266,339.59	\$574,166.09	\$4,336.80	\$11,583.71
1921-22-----	3,863,994.87	1,014,481.32	1,474,669.88	8,440.79	10,511.26
1922-23-----	9,451,445.67	2,180,874.92	2,173,724.67	64,899.22	57,326.78
1923-24-----	12,605,519.22	2,863,999.70	2,692,323.03	101,994.76	58,344.08
1924-25-----	12,870,750.26	3,056,065.95	3,770,876.53	119,199.32	87,322.44
1925-26-----	12,755,382.16	2,779,100.13	3,310,658.54	114,247.75	152,480.36
	53,161,540.30	12,160,861.61	13,996,318.74	413,118.64	377,469.58

Petroleum produced from naval petroleum reserves, by States

State	Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value
California-----	1920-21	1,614,448.12	266,339.59	\$574,166.09
	1921-22	3,863,994.87	1,014,481.32	1,474,669.88
	1922-23	9,084,795.29	2,106,645.04	2,046,619.04
	1923-24	11,346,134.92	2,675,674.75	2,408,799.27
	1924-25	12,123,571.89	2,962,668.64	3,628,089.50
	1925-26	12,234,702.16	2,714,015.11	3,187,461.22
		50,117,647.25	11,739,824.45	13,314,755.00
Wyoming-----	1920-21			
	1921-22			
	1922-23	416,650.38	74,229.88	127,105.68
	1923-24	1,359,384.20	183,324.95	288,423.76
	1924-25	747,178.37	98,397.81	142,837.08
	1925-26	520,680.00	65,085.02	123,197.32
		3,043,898.06	421,037.16	681,563.74

ACTIVITIES ON INDIAN LANDS

On behalf of the Office of Indian Affairs the functions of the division include a variety of services—inspectional, regulatory, and advisory—in connection with mineral development on Indian lands, both tribal and allotted.

In Oklahoma the supervision of oil and gas activities includes 1,260 developed leases involving lands of Cherokee, Choctaw, Chickasaw, Creek, and Seminole Indians, containing about 7,842 productive wells, which yield a royalty income in excess of \$3,700,000; and 66 developed leases of Otoe, Pawnee, Kaw, Kiowa, Ponca, and Sac and Fox Indians, containing 195 productive wells, which yield a royalty income in excess of \$280,000. The supervision of coal-mining operations included at the end of the year 150 leaseholds involving segregated and allotted lands of the Five Civilized Tribes, aggregating 84,702 acres, a coal production in excess of 802,000 tons during the

fiscal year, and an income of approximately \$80,000. The supervision of asphalt-mining operations involves one leasehold of 960 acres. The supervision of lead and zinc mining operations includes 50 leaseholds, aggregating 6,976 acres of restricted allotted lands of Quapaw Indians, which yielded an income of \$1,785,923.40 during the fiscal year. The production from these lands amounted to about 25 per cent of the zinc and 7 per cent of the lead output of the United States.

In Wyoming the supervision of oil and gas activities includes 73 productive wells, 25 of which are shut in awaiting a market for black oil, on the Shoshone Indian Reservation. In New Mexico similar supervision involved 23 productive wells on the Navajo Indian Reservation, which produced about 320,000 barrels of oil during the year.

An important feature of the division's work in connection with Indian lands which includes restricted allotted lands, as well as tribal lands, consists in field investigations of mineral land prior to the granting of leases therefor to determine the feasibility of leasing the land sought, the adequacy of the bonus bid and royalty offered, and the existence on the proposed leasehold of conditions warranting special stipulations in the lease. Field examinations and engineering reports are also made of restricted allotments in connection with applications for removal of restrictions and subsequent sale of the land. During the fiscal year special reports or field investigations made at the instance of the Office of Indian Affairs included asbestos deposits on the Fort Apache Reservation, Ariz.; coal on the Hopi Reservation, Ariz.; gold, silver, and copper deposits on the Gila River Indian Reservation, Ariz.; granite on a Kiowa allotment, Okla.; volcanic ash on a Creek allotment, Okla.; and lead and zinc in Osage Nation, Okla.

COOPERATIVE WORK

In addition to the work for the Navy Department and the Office of Indian Affairs briefly discussed above, cooperative contributions were made to investigations carried on by the Bureau of Mines and Bureau of Standards in connection with the design of mine stoppings to withstand explosions of coal dust, with the explosibility of coal dust, with the amount and character of oils obtainable from coal by distillation and the economic value of the resulting char, and with the country-wide search of the helium division, Bureau of Mines, for sources of helium; and aid was rendered to the Bureau of Reclamation on coal-mining problems.

COST OF SUPERVISION

Preliminary estimates indicate that the cost of the supervisory work of the mineral-leasing division averages about 2 per cent of the aggregate rents and royalties involved, or only one-fifth of the estimated cost of administration when the leasing law was enacted. This cost for essential engineering supervision is materially less than that of similar supervision of operations under private ownership and is more than covered by the economies effected and reflected in immediate royalty returns. The future values preserved by conservation measures established by the supervisory forces and the eventual royalties to be derived therefrom far exceed the current monetary returns from the work of the division.

PUBLICATION BRANCH

DIVISION OF BOOK PUBLICATION

SECTION OF TEXTS

During the year 22,342 pages of manuscript were edited and prepared for printing by the section of texts, and proof sheets comprising 1,831 galley proofs and 11,588 page proofs were read and corrected. Indexes were prepared for 40 publications covering 5,686 pages. Copy and proof or stencils for 654 pages of multigraph and mimeograph matter were read. The book publications of the year are listed and abstracted on pages 7-13. At the end of the fiscal year five persons were employed in this section.

SECTION OF ILLUSTRATIONS

The number of drawings prepared by the section of illustrations was 1,629, including 132 maps, 448 sections and diagrams, 335 photographs, and 714 paleontologic drawings; 131 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany reports numbered 1,685, to be reproduced by chromolithography, photolithography, halftone, zinc etching, combination zinc and halftone, and cuts already engraved. The number of proofs received and examined was 872. At the end of the year material for illustrating 49 reports is in hand. The section now consists of nine employees.

DIVISION OF MAP EDITING

**SECTION OF GEOLOGIC EDITING AND DRAFTING OF MAPS
AND ILLUSTRATIONS**

During the year all the original drafting for the geologic branch was assigned to the section of geologic editing and drafting of maps and illustrations, and the draftsman for the geologic branch was transferred to the section.

The Gillespie-Mount Olive (Ill.) folio (No. 220) was completed and published. The geologic map of Alabama, which was issued by the State Geological Survey, was prepared, its color scheme planned and its engraving and printing directed and supervised in this section. The drawing of the geologic map of Oklahoma was completed, its color scheme planned, and color stones prepared during the year. The maps for the Bessemer-Vandiver (Ala.) folio were engraved and sent for transfer to stone. The Gaffney-Kings Mountain (S. C.-N. C.) folio was prepared, and engraving of the maps was begun. The Somerset-Windber (Pa.) and Coatesville-West Chester (Pa.) folios were received for publication, and their preparation was well advanced. The geologic map of New Mexico reached the stage of color-stone preparation. Some progress was made on the Columbiana-Montevallo (Ala.) and Hollidaysburg-Huntingdon (Pa.) folios.

Maps, sections, and other geologic illustrations for 19 reports were drawn in the section, and numerous diagrams and other sketches for lectures, exhibits, and the Sesquicentennial Exposition were pre-

pared. Illustrations for 22 reports besides the folios and State geologic maps were critically examined and edited in the section.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

During the year 97 topographic maps were edited and transmitted for engraving, 226 published topographic maps, 10 State maps, and 14 State index circulars were edited for reprint, 45 plan and profile river-survey sheets were edited for photolithography, 25 miscellaneous maps were edited for engraving or photolithography, and 305 maps were edited as illustrations for survey reports, a total of 722 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 440 and proofs of maps reproduced by photolithography numbering 261 were read. At the end of the year 91 new topographic maps were in process of engraving and printing. (See also "Topographic branch," p. 56.)

DIVISION OF ENGRAVING AND PRINTING

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the fiscal year 75 new or revised topographic maps were engraved, 51 other new maps were photolithographed, and 2 maps of proposed national parks were compiled by transfers, making a total of 128 new maps printed and placed in the sale stock. In addition, 201 advance sheets of topographic maps were photolithographed and printed. Corrections were engraved on the plates of 226 maps. Reprint editions of 172 engraved topographic maps and 16 photolithographed State and other maps were printed and delivered. In addition, 46 new topographic maps had been engraved and were in press June 30, and the engraving of 16 other new topographic maps was nearly completed. Of new and reprinted maps 316 different editions, amounting to 786,025 copies, were delivered. One new geologic folio was printed, in an edition amounting to 656 copies. Extra geologic maps of folios, numbering 1,637 copies, were also delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, the office of the Secretary of the Interior, the Bureau of Mines, Bureau of Reclamation, Bureau of Education, General Land Office, National Park Service, Office of Indian Affairs, Bureau of Public Roads, Bureau of Agricultural Economics, Forest Service, Weather Bureau, Bureau of Standards, Bureau of Lighthouses, Department of Labor, Department of State, War Department, Post Office Department, Treasury Department, Department of Commerce, Interstate Commerce Commission, Federal Power Commission, International Boundary Commission, Commission of Fine Arts, Civil Service Commission, United States Tariff Commission, National Capital Park Commission, Hydrographic Office, Coast and Geodetic Survey, Alaska Railroad, National Research Council, Federal Farm Loan Bureau, United States Shipping Board, United States Coast Guard, United States Veterans' Bureau, Federal Board for Vocational Education.

cation, Engineer Map Reproduction Plant, National Sesquicentennial Exposition, American Red Cross, and the States of North Carolina, Tennessee, Wisconsin, and Illinois. This work done for other branches of the Government and State governments included many reprints, and the charges for it amounted to about \$118,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the Treasury Department. Other work amounting to \$7,769.90 was done for various State surveys, and payment was effected by transferring employees from Federal to State pay rolls. Transfer impressions numbering 344 were made during the year, including 153 furnished to contracting lithographic printers on requisition of the Government Printing Office, 186 furnished to private firms, 4 furnished to the War Department, and 1 furnished to the Weather Bureau. The amount turned over to miscellaneous receipts from this and other miscellaneous work was \$410.50.

Of contract and miscellaneous work of all kinds, 2,670,797 copies were printed. Including topographic maps and geologic folios, a grand total of 3,458,459 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 9,475 negatives (2,163 wet, of which 928 were for photolithographs, 288 paper, 2,162 dry, 3,956 field negatives developed, and 906 lantern slides), 58,061 prints (33,945 maps and diagrams, 23,184 photographs for illustrations, and 932 rectigraphs), 2,893 zinc plates, 232 zinc etchings, 98 celluloid prints, 126 lantern slides colored, 20 transparencies colored, 10 prints colored, 15 enlargements colored, and 3,760 prints mounted.

DIVISION OF DISTRIBUTION

A total of 390 publications, comprising 72 new books and pamphlets, 1 reprinted book, 1 new geologic folio, 128 new or revised topographic and other maps, and 188 reprinted topographic and other maps, were received by the division of distribution during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 215,126 books and pamphlets, 4,078 geologic folios, 1,637 geologic maps, and 781,947 topographic and other maps, a grand total of 1,002,788.

The division distributed 227,036 books, 8,949 folios, and 760,346 maps, a total of 996,331, of which 7,288 folios and 630,491 maps were sold.

The sum received and deposited in the Treasury as the result of sales of publications was \$47,089.06, including \$44,545.78 for topographic and geologic maps and \$2,543.28 for geologic folios. In addition to this, \$751.80 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$47,840.86. The division received and answered 80,822 letters.

ADMINISTRATIVE BRANCH

SECTION OF CORRESPONDENCE AND RECORDS

The work of the section of correspondence and records was of the same general character as during the fiscal year 1925.

During the year 118,077 pieces of mail, of which 2,058 were registered, were opened and referred. In addition 143,752 letters were received direct by the other divisions, making a total of 261,829, a decrease of 18 per cent compared with 1925, due to the transfer of the mineral-statistics work to the Bureau of Mines. Of the letters opened in this division 20,686 contained \$47,478.57 remitted for Geological Survey publications. The number of ordinary letters mailed through the division was 49,302; of registered letters and packages, 6,305. In addition, 142,077 pieces of mail were sent out direct from other divisions. The total number of outgoing pieces of mail for the Geological Survey was 197,684.

During the year 2,346 pieces of freight and express were handled, 1,150 outgoing and 1,196 incoming.

The roll of Secretary's appointees numbered 845 at the end of the fiscal year, 11 more than at the end of 1925. This is not a significant figure, however, because of the interchange of units with the Bureau of Mines on July 1, 1925. The net change during the year was a reduction of 72. The total number of changes in personnel was 1,151, which included 284 appointments, 273 separations, and 594 miscellaneous changes.

During the calendar year 1925, 17,184 days of annual leave and 3,725 days of sick leave were granted—68 per cent of the amount of annual leave which could have been taken and about 14 per cent of the amount of sick leave it would have been possible to grant. Leave without pay and furloughs amounted to 4,773 days.

LIBRARY

Accessions to the library numbered 14,682 books, pamphlets, and periodicals and 433 maps. The recorded loans were 7,035 books and 284 maps, not including those used by 12,097 readers who consulted the library in person. The catalog was increased by the addition of 8,063 cards. In accordance with the cooperative cataloging arrangements, 810 title entries were furnished to the Library of Congress for printing, the proof reading of which involved 160 galleys.

The correspondence, consisting of 2,118 letters written and 1,752 received, largely concerned the exchange of publications. This correspondence involved the translation of many letters in foreign languages. Foreign articles and letters translated for other divisions of the Geological Survey numbered 219. There were 958 books collated and prepared for binding and 893 newly bound books accessioned and labeled.

Many books were loaned to other libraries and institutions in Washington and in other parts of the country.

Cooperation in the compilation of the "Union list of serials in the libraries of the United States and Canada," to be published under the auspices of the American Library Association, was continued.

The manuscript of the bibliography of North American geology for 1923 and 1924 was submitted for publication in April and is now in the hands of the printer. The preparation of the bibliography for 1925 and 1926 is in progress.

DIVISION OF FIELD EQUIPMENT

On October 1, 1925, the division of scientific and technical equipment and the section of field property were merged and the enlarged unit designated the division of field equipment. This division has continued to repair instruments and other equipment—both field and laboratory—to develop new and improved apparatus for the scientific and technical work, and to care for and issue the equipment required for field work.

SECTION OF ACCOUNTS

Condensed statements covering the expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

GEORGE OTIS SMITH,
Director, Geological Survey.

*Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1928.**

Appropriation	Funds available				Expenditures			Balance	
	Amount of appropriation	Repayments on account of work performed			Total	Disbursements	Outstand- ing liabilities		Total
		For cooperating agencies		For other Geological Survey units					
		Made	To be made						
Salaries.....	\$54,700.00	\$121,519.26	\$18,294.92	\$312.49	\$54,972.49	\$54,263.46	\$5,087.02	\$54,263.46	\$700.08
Topographic surveys.....	593,300.00	2,331.71	2,276.28	16,245.41	714,351.59	702,603.00	5,782.85	713,840.02	1,011.57
Geologic surveys.....	325,000.00	7.00		387.70	329,995.69	319,791.07		325,623.92	4,471.77
Chemical and physical researches.....	40,000.00				40,007.00	39,205.51	483.70	39,689.21	317.79
Mineral resources of Alaska.....	72,000.00	391.66			72,391.66	54,684.05	14,336.54	71,020.59	1,371.07
Gaging streams.....	165,000.00	59,094.87	8,280.10		262,638.31	230,122.57	2,199.09	232,321.66	317.65
Classification of lands.....	265,000.00			324.24	265,844.66	258,271.07	5,014.72	263,285.79	2,560.87
Geologic maps of the United States.....	105,000.00	74,833.80	20,397.94	845.66	263,008.00	205,204.78	14,169.54	219,454.12	8,543.88
Preparation of illustrations.....	18,000.00				18,000.00	17,995.57		17,995.57	4.43
Mining investigations in Alaska.....	22,000.00				22,000.00	19,909.07	1,183.03	21,074.10	922.90
Oil, gas, and oil-shale investigations and leasing.....	249,530.00			5.89	249,535.89	202,732.74	14,768.69	217,488.43	23,147.46
Enforcement of mineral leases.....	86,920.00			480.00	87,370.00	76,630.14	2,070.55	77,695.69	9,674.31
	\$1,952,610.00	258,218.30	49,151.24	41,230.75	2,301,210.29	\$2,187,542.03	\$5,612.83	\$2,283,184.86	\$48,085.78

* In addition to these appropriations, items of \$85,930 for printing and binding Geological Survey publications and \$11,700 for miscellaneous printing and binding were contained in the appropriation act, but the accounts for these items were not kept in the Geological Survey. There was also an allotment of \$6,165 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

* Appropriation was increased by Congress in amount of \$73,300 by act of Mar. 3, 1923.

* Included in this amount is \$41,230.75 covering work performed by Geological Survey units for other Geological Survey units, necessarily reported in combining totals, but otherwise a duplication.

* Of this total, \$8,860 is in the hands of special disbursing agents and therefore has not been included in the classification of expenditures, as no vouchers covering disbursements have been received.

* A budget reserve of \$11,435 is included in this balance.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1926

Object of expenditure	Geo- logical Survey salaries	Topo- graphic surveys	Geologic surveys	Chemical and physical researches	Mineral resources Alaska	Gauging streams	Classification of lands	Geologic maps of the United States	Prepara- tion of illustra- tions	Mining investi- gations in Alaska	Oil, gas, and oil shale investi- gations and leasing	Enforce- ment of mineral leases	Total
Personal services	\$54,263.46	\$522,573.83	\$277,200.01	\$33,901.03	\$45,785.45	\$185,017.12	\$292,106.88	\$170,463.75	\$17,673.44	\$15,617.17	\$146,097.15	\$43,000.41	\$1,724,173.32
Stationery and office supplies	5,227.11	306.92	306.92	33.38	175.72	688.75	323.37	34,543.54	25.18	8.40	2,504.22	921.39	44,704.21
Scientific and educational sup- plies	536.63	1,906.70	1,090.27	56.93	800.36	1,018.83	191.84	191.84	16.57	16.08	646.49	37.59	4,211.63
Sundry supplies	3,483.07	527.78	228.09	228.09	950.60	1,018.83	537.73	6,778.04	16.57	16.08	646.49	37.59	14,263.63
Subsistence and care of animals and storage and care of vehicles	1,924.51	1,000.21	1,000.21	1,000.21	1,000.21	1,000.21	12.00	12.00	12.00	12.00	12.00	12.00	2,902.72
Telephone service	646.65	294.52	294.52	294.52	294.52	294.52	67.91	6.34	119.29	119.29	521.07	58.61	1,977.33
Telephone service	156.77	2.00	2.00	1.30	7.70	484.84	145.64	6.34	101.95	101.95	1,115.60	344.47	2,361.19
Other communication service	12.75	12.75	12.75	12.75	12.75	12.75	6.45	6.45	1.50	1.50	29.15	68.85	88.85
Travel expenses	80,479.05	20,461.40	1,479.86	10,322.81	19,580.60	19,580.60	27,078.43	131.04	4,565.09	12,225.19	9,451.45	191,775.02	191,775.02
Attendance at meetings, hire, maintenance, operation and repair of horse-drawn and motor-propelled passenger-car- rying vehicles	168.44	1,517.47	1,517.47	1,517.47	1,517.47	1,517.47	346.80	346.80	37.71	37.71	39.42	39.42	2,454.39
Transportation of things	5,192.72	2,587.57	995.29	50.00	4,844.17	4,844.17	0,357.10	63.37	15.00	18,716.85	5,256.04	44,014.74	44,014.74
Lithographing, engraving, and stenciling	32,628.55	5,161.94	41.52	705.55	1,994.05	1,994.05	6,485.34	63.37	102.02	1,320.43	596.24	40,071.05	40,071.05
Stenographic work, typewriting, and duplicating work, etc. (Job work)	9,581.12	1,229.58	24.82	79.85	426.55	426.55	3,283.13	80.00	103.19	13.29	102.73	14,818.24	14,818.24
Photographing and making pho- tographs and prints	15.56	17.63	17.63	47.50	47.50	47.50	8.75	8.75	12.65	305.85	107.94	16,397.46	16,397.46
Heat, light, power, water, and electricity	9,113.75	3,716.25	165.82	292.20	935.46	935.46	1,584.33	1,584.33	220.80	777.36	5.02	1,065.05	1,065.05
Rents	20.75	88.66	166.11	24.50	425.16	425.16	22.25	1,014.85	25.08	2,306.00	735.01	4,120.83	4,120.83
Repairs and alterations	125.72	88.66	166.11	24.50	425.16	425.16	22.25	1,014.85	25.08	2,306.00	735.01	4,120.83	4,120.83
Special and miscellaneous current expenses	9,243.09	4,819.54	553.46	1,016.80	746.66	746.66	5,791.61	2,189.89	30.00	1,118.10	212.15	25,727.28	25,727.28
Purchase of passenger-carrying vehicles	900.50	900.50	900.50	900.50	900.50	900.50	3,785.00	3,785.00	14,770.85	5,148.25	29,731.16	8,699.50	8,699.50
Furniture, furnishings, and fix- tures	1,548.77	410.38	100.97	100.97	810.79	810.79	918.54	50.00	20.00	3,344.05	1,164.90	17,694.36	17,694.36
Educational and scientific equip- ment	6,298.80	2,741.83	997.06	425.46	4,411.74	4,411.74	1,526.61	161.39	136.40	729.23	324.94	3,159.50	3,159.50
Livestock	839.50	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,320.00	3,971.91	96.75	879.20	81.16	28,751.45	28,751.45
Other equipment	17,580.85	240.46	1,068.70	3,440.43	263,285.79	263,285.79	219,456.12	17,995.57	21,074.10	217,496.43	77,083.69	2,241,294.56	2,241,294.56
	51,263.46	325,723.92	39,689.21	62,160.59	232,321.06	232,321.06	263,285.79	219,456.12	17,995.57	21,074.10	217,496.43	77,083.69	2,241,294.56

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U. S. DEPARTMENT OF THE INTERIOR

ANNUAL REPORT

OF THE

DIRECTOR OF

THE GEOLOGICAL SURVEY

TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1927



DEPARTMENT OF THE INTERIOR
Hubert Work, Secretary

U. S. GEOLOGICAL SURVEY
George Otis Smith, Director

FORTY-EIGHTH ANNUAL REPORT

OF THE

**DIRECTOR OF
THE GEOLOGICAL SURVEY**

TO THE

SECRETARY OF THE INTERIOR

**FOR THE FISCAL YEAR
ENDED JUNE 30**

1927



**UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1927**

Directors of the Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907

GEORGE OTIS SMITH, 1907-

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ANNUAL REPORT

OF THE

DIRECTOR OF THE GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 15, 1927.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1927 included 10 items, amounting to \$1,819,440. In addition \$81,000 was appropriated for printing the reports of the Geological Survey, and \$11,000 for miscellaneous printing and binding, and an allotment of \$13,707 for miscellaneous supplies was made from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of this report. The balance on August 30, including a budget reserve of \$26,620, was \$51,331.24.

EXTENT OF COOPERATION

Early in the history of the United States Geological Survey the critical question whether State and Federal surveys were to be competitive or coordinated was answered by a declaration of Federal policy urging the creation and continuance of State surveys. How effective the cooperation has been is shown by the fact that last year 38 States and Hawaii contributed \$738,056 to the mapping and investigative work under the Federal Geological Survey, or a sum equal to two-fifths of the funds appropriated by Congress. In the topographic mapping the Federal appropriation was augmented 90 per cent by State funds, and in the investigations of water resources the States added 200 per cent. This is unmistakable evidence of the growing spirit of cooperation between public officials. The financing of cooperative effort, however, should be more equitably divided between State and Federal Governments in the gaging of streams, where the reasons for a dollar-for-dollar arrangement are similar to those now recognized and generally adopted in the topographic mapping.

There is a common interest of Federal, State, and other governmental agencies in the possession of adequate base maps covering their territory and of authoritative information regarding the natural resources on which depend their present progress and future prosperity. By means of such cooperation the States utilize the trained expert personnel and standardized methods of the Geological

Survey, the overhead costs are limited to one administrative organization instead of being multiplied by distribution among many, profitless duplication of work and effort is avoided, the results of the work have a uniformity that makes them more useful, as well as a high standard that is generally recognized and widely accepted, and other obvious economies to the public in the dissemination of authoritative official information are effected.

In addition to this cooperation with the States, services were rendered to other Federal departments, bureaus, and offices, and to permittees of the Federal Power Commission, to the amount of \$305,631. The total amount of funds made available from all sources for disbursement by the Geological Survey was \$2,388,893, and in addition State funds directly disbursed for work administered by the Federal officials brought the total up to \$2,863,127, which is the proper measure of the amount of work accomplished during the year.

This function of the Federal bureau in effecting a country-wide coordination of investigations within its several fields of activity is not exercised by statutory authority but only because of a growing appreciation of common interest by all parties to the cooperative agreements or arrangements. The coordinated effort is more efficient in results and more economical in costs. The whole public is best served by cooperation.

SCOPE OF INVESTIGATIONS

Primarily a field service, the Geological Survey has always put the emphasis on its field projects, its field workers, and the results of its field investigations.

The basic idea of the Geological Survey's work is the application of scientific methods by scientists to practical tasks for the general good. Its fact finding is a continuing inventory of natural resources—an aid to the discovery, development, and wisest use of the country's mineral wealth. The standards in useful geology, in usable topographic maps, in authoritative stream gaging have all become higher as better methods have been developed. Moreover, it is necessary not only to apply the scientific principles already known but also to carry on research so as to develop more knowledge and new principles for the use of future workers both in and outside of the Geological Survey.

In the scope of its field work the Geological Survey changes little from year to year, but there is progress in adapting its investigation to serve better the many purposes incident to national progress. At different periods in its history, therefore, the demand for accurate and authoritative information essential for national development has varied both in kind and in intensity. Thus geologic surveys, which early sought to guide the search for metallic wealth and later gave larger attention to the mineral fuels, now again stress the study of ore deposits directly applied to ore finding. Investigations of the water resources of the country at first sought to furnish the answer to the great agricultural problem of utilizing the wide expanses of arid lands in the West; then stream measurements took on a broader aspect, with power development as an added purpose; quality of

water as well as the quantity available for industrial and municipal use was found to be a necessary subject of study, and aid was also sought in the solution of the great engineering problems connected with land drainage and protection against flood. By similar evolution the topographic mapping has progressed from the small-scale reconnaissance type of surveys to the more detailed and more exact methods that yield a product which can be and is used in planning all kinds of engineering projects, from highway construction to discovery of oil-field structures or of water-storage sites.

All such work is truly productive, though the connection between the preliminary fact finding or the basic survey and the industrial development or engineering construction may be later unrecognized or forgotten. Indeed, the field investigation is doubly productive if it has been made sufficiently in advance to initiate the utilization of the resources of a region and promote their best development. Such was the purpose of the reservoir-site investigations by the Geological Survey in 1889, although some of the sites then discovered and described were not needed for several decades. Fact finding can never be conducted too early to be most effective, for having facts in reserve is the best kind of national preparedness.

Another example of productive investment in fact finding on a comprehensive scale is afforded by the Geological Survey's program of intensive study of the coal fields of the West, continued during the last 20 years. During that period approximately a million dollars of the public funds, appropriated for geologic surveys, has been expended in the areas where the Government itself is owner of many millions of acres of coal lands. That examination of the Nation's landholding and the inventory of the coal in public ownership has not only contributed to the popular realization of the extent of this large estate but also helped materially in bringing about the enactment of laws better fitted to its administration in the public interest. In the seven years since the passage of the leasing law nearly 10,000,000 tons of coal has been mined from these lands, with a return in royalty of approximately \$1,250,000. Last year alone the output of these leases was 2,500,000 tons and the royalties and rents amounted to nearly \$300,000—a fair return on the investment of a million dollars in determining the extent and value of the estate—and of course the mining on these public coal lands has only begun. Moreover, it should be noted that this fact finding has contributed equally to the development of the private coal lands in the same regions, title to which had earlier passed from the Government.

A topographic map often pays for itself in the saving made possible in the selection of an easier railroad cut-off or a shorter highway route, and a single oil pool located by means of a new topographic map may outweigh in value to the country the year's total appropriation for topographic surveys. Or a great power project may have revealed itself to an engineer solely from his study of the topographic map of a drainage basin and the stream gagings of one or more rivers, and through the development of that project the industries of several States will profit for centuries.

Not only can such examples be cited of investments in surveys and examinations and studies that pay handsome dividends to the public, but there is abundant reason to believe that most if not all of these

expenditures for fact finding pay for themselves with a wide margin of profit. Indeed, it is well known that the investigations that yield negative or unfavorable results usually save much greater expenditures in projects that would have proved failures. Such findings of fact are not popular, but they may prevent large waste of capital and labor.

The brief summary of the year's operations, on pages 5-9, and the more detailed catalogue of explorations, investigations, and surveys that make up the body of this administrative report give a picture of the wide variety of work undertaken in the Geological Survey's effort to apply science to serve human needs. Every project is planned to be productive, but much of the work is necessarily fundamental and, although regarded as absolutely essential, is not expected to yield immediate results. The insistent demand by engineers for reprints of some Geological Survey reports many years out of stock is a practical measure of the continuing value of investigations long since made. Scientific fact finding, whether its product is a topographic map or a table of stream discharge or a geologic description, is a piece of productive work, possessing both immediate and future value. Expenditures for such work constitute an economic investment.

DUTY OF PUBLICITY

To reach the public with the facts is an essential part of Government research. The Geological Survey's policy in securing prompt and wide publication of the results of its scientific work was described in the Fortieth Annual Report as including the use of newspaper notices of its publications—a type of publicity often criticized yet well warranted if the effort is made to advertise not the bureau or its personnel but its product, utilizing mediums of publication other than the official reports, such as the technical journals, transactions of scientific societies, and the reports of State surveys, and answering every inquiry not only by sending carefully selected publications on the subject but by writing more specific information than is included in Geological Survey reports or by referring to the State surveys as sources of further information.

This policy has continued unchanged, except possibly for the increasing use of the cooperative State surveys for publication and the encouragement of the contribution of timely articles to the technical journals. The guiding test is promptest announcement and widest circulation of facts resulting from the Federal scientific work.

The present rate of expenditure for the Geological Survey's own publications is less than half that of 10 years ago, and the volume bears much the same relation, the number of reports being reduced one-half, with less than half the total number of pages, and the average edition being now less than 3,000 copies, as against 5,000 copies 10 years ago. Yet the number of manuscripts being prepared has not materially decreased nor is the general demand for published reports less, so that the larger printing appropriation available for the present year is well justified. The distribution of reports during the year exceeded by 10 per cent the number currently printed. The distribution by sale has been encouraged, and the report of the Superintendent of Documents shows a constant increase in total sales

of the Geological Survey publications, the number sold and the money received being more than seven times the corresponding figures 20 years ago. Reports 30 and 40 years old continue to sell, and some technical books with special educational value are in daily demand. The most embarrassing demand is the request from engineering organizations and the general public for reprints of several reports long out of stock. The expenditure necessary to meet such requests can not be logically made with so many unpublished manuscripts waiting their turn, yet the demand shows the permanent value of the investigations represented in such reports.

The steadily increasing number of maps sold is likewise proof of public recognition of their usefulness. Last year the number of maps distributed, mostly by sale, exceeded the number printed by nearly 100,000.

The extent of outside publication of scientific results is indicated roughly by the statement that 17 manuscript reports were delivered to cooperating State surveys for publication at their expense, and the scientists and engineers contributed 127 articles dealing with their official work to the technical press. The daily newspapers also gave wide publicity to the statements setting forth the results of work in progress or describing and summarizing the reports as published. The amount of information given in response to mail inquiries can not be measured, but the handling of that type of correspondence has been a heavy burden on the technical staff, although the highly appreciative letters received are convincing evidence that the expenditure of time is a proper and necessary service to the public.

NECROLOGY

Charles D. Walcott, Secretary of the Smithsonian Institution, who died on February 9, was the third Director of the Geological Survey. The years of his administration, 1894 to 1907, were the years of largest growth for this Federal bureau, and his service as a public official and as a scientific investigator had a large share in determining the Geological Survey's sphere of usefulness.

Two other of the older members of the geologic staff died during the year—William H. Dall, a paleontologist actively engaged in work of the highest grade since his appointment to the Geological Survey in 1884, and F. H. Knowlton, paleobotanist of the Geological Survey since 1889. These three investigators, working in widely separated fields of paleontologic research, contributed largely to the Geological Survey standards and reputation.

THE YEAR'S OPERATIONS

The principal activity of the director, outside of his routine administrative duties, was service as chairman of the advisory committee selected by the four Cabinet officers forming the Federal Oil Conservation Board, to assist them in their general study of the petroleum problem, and as chairman of the Naval Oil Reserve Commission. In addition to this service he made addresses or informal talks at several scientific and technical meetings and contributed articles to the press, in order to give wider circulation to some of the

salient results of the Geological Survey's work that are of general public interest. A list of these addresses and articles is given below.

- "The ever-new West," Western States Convention, Denver, September 22.
- "Geology at work," Johns Hopkins University, October 22.
- "The forward look by the Department of the Interior," Worcester Polytechnic Institute, Massachusetts, March 24.
- "What price distance," International Railway Fuel Association Convention, Chicago, May 10.
- "Practical conservation," a letter to the Secretary of the Interior, released to the press August 17.
- "Cooperative research essential," Oil and Gas Journal, September 23.
- "Fuel for 1927," New York Journal of Commerce, January 1.
- "America in the making," D K E Quarterly, May.
- "The Geological Survey," United States Daily, May 28.
- "Evolution in the natural-gas industry," Oil and Gas Journal, June 16.

The branch chiefs and the administrative geologist also represented the Geological Survey at technical or other meetings and spoke on various subjects, a few of which are listed below.

- "Surveying and mapping in the United States," by C. H. Birdseye, American Society of Civil Engineers, Philadelphia, October 6.
- "The American petroleum situation," by Julian D. Sears, Postgraduate School, Naval Academy, Annapolis, Md., February 5.
- "A trip down the Colorado River," by C. H. Birdseye, Women's City Club, Washington, D. C., March 9.
- "Some post-Tertiary changes in Alaska of possible climatic significance," by Philip S. Smith, American Geophysical Union, April 19.
- "Floods and flood control," by N. C. Grover, Illinois River Flood Control Association, Peoria, Ill., May 7.

A brief summary of the work done by the Geological Survey during the fiscal year is given in the following paragraphs:

GEOLOGIC WORK

Geologic work was done in 42 States, Alaska, the District of Columbia, and Hawaii. In this work 17 of the States cooperated. The cooperative work takes a variety of forms but consists mainly of the study of specific problems on a cost-sharing basis. Among the major results of such work are a new geologic map of Alabama, issued by the State Geological Survey, and a new geologic map of Oklahoma, issued by the United States Geological Survey. Contributions were also made to proposed geologic maps of Arkansas, Colorado, Florida, Texas, and Virginia. Cooperative investigations bearing on oil and gas resources were made in five States, on metalliferous deposits in two States, and on general geologic problems in four States. Considerable geologic work was also done in cooperation with other Government organizations and with non-governmental scientific associations. The investigations in search of potash, carried on in cooperation with the Bureau of Mines, centered largely in New Mexico, where three sites for core drilling were selected, and the drilling at two of them was completed. The cores were studied and selected portions analyzed, and preliminary reports on the economic results were nearly finished. Volcanologic studies were carried on in Hawaii, and a station for volcanologic investigations was established in California. Numerous paleontologic determinations were made. Investigations of ore deposits, coal, oil shale, and other minerals and studies in glacial geology, stratigraphy, and structure were continued. In the chemical laboratory 2,874 specimens were identified for private persons and 4,268 were chemically or mineralogically examined, including 3,055 samples taken from wells being drilled for oil in the Texas-New Mexico potash field. Further work was done on problems connected with the soda process for petroleum recovery.

EXPLORATIONS IN ALASKA

In the field season of 1926 the principal new explorations that were conducted by the Geological Survey in Alaska covered about 7,000 square miles of hitherto unmapped country. Three major exploratory expeditions were

gaged in this work—one in extreme northwestern Alaska, another in the Alaska Range north of Mount Spurr, and the third in the wilds north of the Yukon, a little west of the Alaska-Canada boundary. The explorations in extreme northwestern Alaska were part of a search for oil that the Department of the Interior has carried on for several years at the request of the Navy Department. The geologist and topographic engineer assigned to this work left Washington in February, went as far as possible by the customary routes of transportation into central Alaska, and thence, with their own dog teams, traversed more than 700 miles to the settlement nearest the area to be surveyed. There the party procured all the equipment and supplies that would be required for several months' exploration by dog teams and canoes and struck off into the unsurveyed region, to remain as long as conditions permitted. The expedition into the Alaska Range worked with a pack train of 17 horses and subsisted itself and carried on its assigned tasks for more than three months in that remote region, where even travel is extremely arduous and difficult because of the ruggedness of the topography and the swiftness and volume of the streams. The surveys north of Yukon River necessitated strenuous travel with canoes up an unmapped river for scores of miles and scouting trips on foot to such points as would afford sighting stations from which to reconnoiter the adjacent country and determine its geologic and geographic features.

In the field season of 1927, the expenses for which were in part borne by the appropriation for 1926-27, the exploratory work was continued in both the Alaska Range country and in the region north of the Yukon adjacent to areas where work was done during the field season of 1926.

Not all the work in Alaska is of the exploratory type, however, for the Geological Survey's investigations also include study, mapping, and reporting on the already developed mineral deposits in or adjacent to the settlements and in the more accessible and well-known parts of Alaska. In fact, the task of assisting the development of the Territory's mineral resources in any way that lies within its power and resources is regarded as a distinctive duty of the Interior Department.

One of the noteworthy projects undertaken was the photographing from airplanes of a large part of southeastern Alaska by an expedition of the Navy Department in the field season of 1926, at the request of the Department of the Interior. The expedition accomplished noteworthy results in photographing so large a tract of an extremely difficult topographic area under adverse climatic conditions. Nearly 6,000 photographic exposures, each consisting of three separate parts, were made in the course of this work. The photographs were made under such conditions and controls that they can be utilized by the Geological Survey in preparing maps of the region which will serve for bases for further geologic and topographic investigations. At the same time these bases and the maps subsequently to be prepared from further field surveys will be available for the use of all other Government departments concerned with any phase of the development of southeastern Alaska and for prospectors and other people of that region.

TOPOGRAPHIC MAPPING

The topographic work was done in cooperation with 26 States, and the area mapped amounted to 17,603 square miles in 30 States, the District of Columbia, and Hawaii. Of this total 14,630 square miles represents new surveys, 1,990 square miles resurveys, and 983 square miles revisions. The total area mapped to June 30, 1927, is 1,300,539 square miles. Nine States and the District of Columbia are now entirely mapped, and the percentages in the other States range from 8 to 88. Of the total continental United States exclusive of Alaska, 42.8 per cent has been mapped. River surveys amounting to 300 linear miles were also made. In connection with the topographic work 5,198 miles of spirit levels and 3,287 miles of transit traverse were run and 38 triangulation stations were occupied. Cooperation was continued with the Air Corps, United States Army, whereby aerial photographs were furnished for use in topographic mapping. A new base map of the United States was completed.

INVESTIGATIONS OF WATER RESOURCES

The work on water resources is done largely in cooperation with other Federal bureaus, with State, county, and municipal agencies, and with permittees and licensees of the Federal Power Commission. The amount expended by

State, county, and municipal agencies for such work during the year, in part directly and in part through the Geological Survey, was \$301,459. This sum covered work in 30 States and Hawaii. Including the cooperative work, the study of surface waters, which consists primarily of the measurement of the flow of streams, was carried on in 41 States and Hawaii, in which at the end of the year 1,749 gaging stations were being maintained. The work on ground-water resources has been planned to meet the increasing public demand for precise information with increasing need for the water. Investigations relating to ground water and reservoir sites were made in 16 States and Hawaii. Considerable research into the principles of hydrology has been undertaken in order to provide a more secure basis for ground-water investigations. A hydrologic laboratory and three experiment stations have been maintained, 30 automatic water-stage recorders have been installed over observation wells, and thousands of measurements of water levels in wells have been made. Cooperation was continued with well drillers' associations with a view to developing higher standards and better results in water-well drilling. The work on quality of water involved the examination of 752 samples. The investigations of power resources included the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants and a report on the developed and potential water power of the United States.

WORK IN CLASSIFYING AND LEASING PUBLIC LAND

The work of classifying public and Indian lands with respect to mineral content and of supervising mineral operations on such lands was carried on in 23 States and Alaska. The number of cases involving land classification acted on during the year was 12,735, and the results accomplished include net decreases of 604,223 acres in the area of outstanding coal withdrawals, of 529,363 acres in outstanding petroleum withdrawals, and of 11,410 acres in outstanding phosphate reserves. At the end of the year the total area classified amounted to 38,539,905 acres in 15 States and the outstanding mineral withdrawals to 44,969,394 acres in 14 States. Definition of the "known geologic structure" of producing oil and gas fields was continued, and at the end of the year the net area so defined was 512,843 acres in seven States. Investigations to obtain information for classifying public land with respect to its value for the development of water power were made in four States. There was a net increase of 484,346 acres in the area included in power reserves, making a total of 6,090,008 acres in 21 States, on which about 15,000,000 continuous horsepower can be developed. The net increase in enlarged-homestead designations was 65,078 acres, making a total outstanding of 324,862,893 acres in 16 States, and the net increase in stock-raising homestead designations was 1,042,324 acres, making a total outstanding of 118,100,670 acres in 18 States. There was a net increase of 3,730 acres in public-water reserves, and the total outstanding is now 364,777 acres in 12 States. The supervisory work on public lands subject to the mineral-leasing laws was increased between 10 and 15 per cent by the receipt of 78 leases, 4,749 permits, and 16 licenses, covering 8,588,925 acres. The production of petroleum on such lands during the year was 25,648,101 barrels, on which the royalty value was \$8,006,455, and the production of coal on such lands was 2,513,080 tons. Supervision over oil and gas operations on naval petroleum reserves was continued, and the petroleum produced amounted to 12,725,365 barrels, on which the royalty value was \$3,455,731. Inspectional, regulatory, and advisory service was rendered in connection with the leasing of mineral deposits on Indian lands in seven States.

PUBLICATIONS

The publications of the year consisted of 66 books and pamphlets of the regular series (including 1 reprint), 112 new or revised maps, 140 reprinted maps, and numerous circulars, lists of publications, etc. The total number of pages in the new book publications was 8,396. In addition to the publications in the regular series 47 brief reports were issued in mimeographed form as memoranda for the press. The manuscript edited and prepared for printing amounted to 21,377 pages; 1,832 galley proofs and 14,280 page proofs were read and corrected. Indexes were prepared for 32 publications, covering 5,214 pages. The drawings prepared for publications numbered 2,500, and the proofs of

illustrations examined 1,964. Maps for 8 folios were wholly or partly prepared for engraving, and maps and illustrations for 30 other reports were edited. The new topographic maps edited and transmitted for engraving numbered 122, and 713 other maps were edited. Map proofs numbering 611 were read. Of new and reprinted maps and folios 653,535 copies were printed. The publications distributed numbered 950,840, of which 8,023 folios and 609,148 maps were sold for \$46,116.32.

GEOLOGIC BRANCH

W. C. MENDENHALL, Chief Geologist

ORGANIZATION

The work of the geologic branch has been administered during the year through 11 units, representing topical or geographic groupings of activities. These units are as follows:

Paleontology and stratigraphy, T. W. Stanton, geologist in charge.
 Geology of metalliferous deposits, G. F. Loughlin, geologist in charge.
 Geology of nonmetalliferous deposits, G. R. Mansfield, geologist in charge.
 Geology of iron and steel metals, E. F. Burchard, geologist in charge.
 Glacial geology, W. C. Alden, geologist in charge.
 Coastal Plain investigations, L. W. Stephenson, geologist in charge.
 Areal geology, H. D. Miser, geologist in charge.
 Geology of fuels, W. T. Thom, jr., geologist in charge.
 Volcanology, T. A. Jaggar, jr., volcanologist in charge.
 Petrology, C. S. Ross, geologist in charge.
 Chemistry and physics, George Steiger, chemist in charge.

The section of volcanology was established July 1, 1926, with the Hawaiian station as headquarters, and T. A. Jaggar, jr., in charge. H. D. Miser succeeded Sidney Paige as geologist in charge of the section of areal geology.

The professional force was increased by the appointment of two assistant geologists, two junior geologists, and one junior chemist and the transfer of one assistant topographic engineer and was reduced by one death, two transfers, and the dropping of one. With these changes it now includes 103 geologists of various grades, 8 chemists, 2 physicists, 1 laboratory aid, and 1 assistant topographic engineer. Six draftsmen (2 temporary) and 7 preparators of fossils (2 temporary) constitute the subprofessional force. In the clerical force there were 3 accessions (2 appointed for field offices) and 2 separations, one by transfer to the professional staff and one by resignation, leaving a total of 30 clerks of various grades, 2 of whom are temporary.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the geologic branch for the fiscal year were as follows:

Geologic surveys.....	\$337, 160
Classification of lands.....	34, 300
Mineral leasing.....	900
Investigating potash deposits.....	7, 500
Volcanologic surveys.....	25, 000
Repayments from other departments.....	2, 211
Repayments from State organizations.....	17, 183
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	424, 254

The expenditures from these funds may be classified approximately as follows:

Geologic investigations (economic and scientific)-----	\$297, 754
Hawaiian volcanology-----	24, 500
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc-----	95, 000
Budget reserve and unexpended balances-----	7, 000
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	424, 254

COOPERATION

Cooperation in geologic work continues with a number of the States and takes a variety of forms. In general, the Federal Survey staff makes many paleontologic identifications for States and assists in problems of correlation and identification of materials. Usually, however, the cooperation takes the form of a study of specific problems on a cost-sharing basis. These problems may include the preparation of reports on particular resources or particular areas. They not infrequently lead to the preparation of geologic State maps. The resulting maps and reports are published either by the State or by the Federal Survey. By such cooperation there is coordination of State and Federal action, avoidance of duplication, reduction of cost, and standardization of product.

GEOLOGY AS AN AID TO MINING

Metal mining in the United States has reached an interesting and to many a baffling stage. During the half century of development that followed the discovery of gold in California one great bonanza after another was discovered in the West. These poured into the coffers of the world a wealth of metals which enriched its finders, the Nation, and all mankind. The country was new. The western half of our continent had remained, in the mining sense, undiscovered. Enterprising Americans in 75 years have concentrated the exploration and development that in the Old World was distributed over many centuries. Viewed historically this development has been startlingly swift; nevertheless it has been remarkably thorough.

Now the pioneer stage of mining has passed. In an untouched country simple methods of prospecting revealed great mineral deposits in quick succession, many of them exposed at the very surface, awaiting merely the touch of the prospector's pick and the assay to confirm his findings. Many of the deposits thus discovered were developed into great mines, which have passed through successive stages of cheap mining of rich oxidized ores at the surface, more expensive but highly profitable mining of enriched sulphides at greater depth, and finally mining of lean primary ores at lower levels, where costs of recovery even with the best modern methods may soon exceed the market value of the product.

But as time has passed fewer and fewer new deposits have been found. The hills have been prospected over and over by the old-time methods from base to summit, from Canada to Mexico, and from the Great Plains to the Pacific. An occasional strike has been made within the last third of a century—Cripple Creek in 1891, Tonopah

and other Nevada camps in 1900 and later—but by far the greater number of the big metal mines of the United States were in operation within two generations after the discoveries in California. The finding of new ore bodies is becoming more difficult, and the difficulty may be expected to increase. The problem of maintaining production involves increasing skill in ore finding and increasing use of lower-grade material. The first is the problem of the geologist and the mining engineer; the second is the problem of the metallurgist and the industrial organizer.

The leaders in the mineral industry are acutely aware of the necessity of finding more ore, even though the rest of the world may be oblivious to this need. The information of mankind in general lags years or decades or generations behind the information of the specially informed groups. The present has been termed peculiarly a mineral civilization, and the future demand for the ores of the useful metals, raw materials absolutely essential to general prosperity, threatens to increase faster than the supply. Any shortage in these essential metals will inevitably result in higher prices paid by consumers and a halt in the increasing use of those raw materials that vitally contribute to our civilization.

To stimulate this necessary search for ore is involving the use of geology more and more as realization of the nature of the problem grows. That is inevitable. Ore deposits are geologic deposits; they are a part of the crust of the earth, with which geology deals, and they have come into existence through the operation of geologic processes. Now that the visible outcropping ore bodies are largely known and developed, the task of finding the hidden reserves becomes peculiarly a task of applying geologic reasoning to geologic fact. It is an obscure and difficult search. Ore deposits are among the most complex of geologic deposits, for the processes which produced them are many and varied; but what is known of them has been learned by the geologists and their allies—the mining engineers, the geochemists, and the geophysicists.

The mining industry now demands all that geology can do to help it solve the problem of ore finding. Some of the great mining companies have organized large geologic staffs, which are constantly engaged in exploration and the direction of development work. Despite the limitations involved in private work of this sort, the results have been highly successful from the point of view of the companies and their associates. But the mining public as a whole has not reaped the full benefit of this work, because the results are not made public.

Mining districts and the public-land States have sought the aid that they have a right to expect from the Government geologic staffs. Their pleas are not uninformed; on the contrary, they are based on wide experience. For nearly 50 years the United States Geological Survey has made monographic studies of the great mining camps. Its publications have not merely represented great advances in the theory that sets forth how and where ore deposits are formed—many of them rank as classics in the world's literature on this subject—but they have been of great practical value. The development of many of the chief centers of mineral production has been guided in an important and constructive way by the relations which these studies

have revealed of ore bodies to particular rock masses and to particular features of the geologic structure.

The old Leadville monograph, published by the Geological Survey in 1886, is referred to by the mining men of Leadville as the miner's Bible, and the professional paper descriptive of the same mining district of to-day has been referred to as "the revised version." The mining industry urges geologic research—not private, not limited to one property or group of properties, not available merely to one board of directors, but available to the whole mining public and directed to its needs.

Geologic work of this type will necessarily guide the prospecting of the future, utilizing all that has been learned about the hiding places of the elusive metals. Making use of geologic maps of high accuracy, it will point out the situations that experience indicates are promising places in which to search for ore. Exploration thus directed must replace the haphazard, largely wasted work of which so much has been done in the past. It will concentrate search in areas where there is reasonable hope of success. It should reveal much ore not now known and should greatly reduce the cost of ore finding.

"Guides to ore in the Leadville district," recently issued as Geological Survey Bulletin 779, is a brief report in which the practical suggestions resulting from a detailed study of the district are summarized in directly usable form. It represents a type of other examples to follow.

The State of Colorado has recently taken practical steps to procure the sort of geologic work that has just been outlined. In the past this State has produced a billion and a half of dollars in metals, but many of its great camps are on the decline because of the exhaustion of the known ore bodies. In its desire to get the benefit of broad, systematic geologic work, directed especially toward the practical end of ore finding, it has proposed and obtained cooperation with the United States Geological Survey. To this end it is utilizing its metal-mining fund, augmented by a special appropriation by the State legislature. The work is under way. Experienced mining geologists from the Geological Survey have been assigned to the State. Topographic base maps on adequate scales are being made where they are needed. The mineral belts of the State will be mapped in detail, beginning with the better-known areas, on many of which good reports already exist, and passing thence to areas that are less well known. The results are expected to be such enlightening guides to a search for ores as can be given by modern geologic science. The revival of metal mining is not merely an ambitious local project; it is part of a necessary national program to safeguard the continuance of national prosperity.

WORK IN GEOLOGY BY STATES

ALABAMA

Several collections of material from deep wells and surface outcrops were examined and reported on in informal cooperation with the Geological Survey of Alabama. A new colored geologic map of the State, on a scale of about inches to the mile, prepared cooperatively by the Alabama Geological Survey and the United States Geological Survey, has been issued by the State survey.

It is accompanied by an explanatory text, which includes chapters by George I. Adams, of the Alabama Geological Survey, and Charles Butts, L. W. Stephenson, and C. Wythe Cooke, of the United States Geological Survey.

ALASKA

A reconnaissance of the Alaskan Peninsula and the Aleutian Islands has been carried on by T. A. Jaggard, with a view to establishing permanent stations for continuous observation of volcanologic and seismologic phenomena.

ARIZONA

Brief examinations of the iron-ore deposits near Tucson, Ariz., and of the fluor spar deposits near Yuma, Tucson, and Duncan were made by E. F. Burchard. A report on the Kaiparowits region, in Utah and Arizona, was submitted by H. E. Gregory and R. C. Moore. F. E. Matthes cooperated with the National Park Service in supervising the construction of a relief model of the Grand Canyon, under the auspices of the American Association of Museums. Paleontologic exhibits in situ at points visible from Yavapai Point, Grand Canyon, were prepared by David White, who held conferences regarding the field observation station to be established there. This work was done in cooperation with the National Park Service, American Museum Association, a National Academy committee, and the National Museum. Cooperation with the State Bureau of Mines consisted in the determination of several lots of fossils by Edwin Kirk, G. H. Girty, and W. C. Mansfield. Bulletin 782, by Waldemar Lindgren, "Ore deposits of the Jerome and Bradshaw Mountains quadrangles," which include the famous United Verde and United Verde Extension mines, was issued.

ARKANSAS

In studying the occurrence of oil in southern Arkansas and northern Louisiana, geologists have had difficulty in correlating the oil-bearing and associated rock formations penetrated by the drill with the same formations where they rise to the surface north of the oil fields. To help in this problem a careful survey was made of the areal distribution and stratigraphic relations of the formations of Cretaceous age in southwestern Arkansas, and a report by C. H. Dane will be published by the Geological Survey of Arkansas. A preliminary report entitled "Oil-bearing formations of southwest Arkansas" was issued as a press memorandum. The deposits of lead and zinc ores in Sharp and Lawrence Counties, mined in small quantities for many years, have received renewed interest as a result of recent prospecting. In an endeavor to determine the prospective value of the field for mining, a brief study of the old mines and prospects, as well as new workings, was made by H. D. Miser, who gave his results in a memorandum for the press. At the request of the Forest Service, forested areas adjacent to the Ozark National Forest were examined to determine whether geologic conditions are such that the purchase of the areas as additions to the national forest would tend to conserve navigation on White, Arkansas, and Mississippi Rivers, into which their waters flow. The Woodbine sand in Arkansas, made up largely of water-laid volcanic material, was traced westward through Oklahoma into northeastern Texas, and there found to pass into the typical Woodbine sand, only partly composed of volcanic material. A report on these rocks was prepared by C. S. Ross, H. D. Miser, and L. W. Stephenson and transmitted for publication. A paper by H. D. Miser describing the relations of the Lower Cretaceous rocks of southeastern Oklahoma and southwestern Arkansas was published in the Bulletin of the American Association of Petroleum Geologists. The exact age of certain beds of Carboniferous sandstone and shale nearly 3 miles thick in the Ouachita Mountains has long been a puzzle to geologists, because of the scarcity of fossils. A paper on their age has been prepared by Mr. Miser, in collaboration with C. W. Honess, formerly a geologist of the Oklahoma Geological Survey. The study and description of the fauna of the Morrow formations was continued by G. H. Girty. The relations of formations beneath the St. Peter sandstone were studied by E. O. Ulrich. Early Paleozoic invertebrate fossils were collected by R. D. Mesler in northeastern Arkansas. A paper by George H. Girty on the fauna of the middle Boone at Batesville, with a brief description by H. D. Miser of the Boone chert near Batesville, was transmitted for publication. Much information has been supplied for a new colored geologic map of Arkansas, which is in preparation by the Arkansas Geological Survey.

CALIFORNIA

The general geology and oil possibilities of the southwestern and west-central parts of Humboldt County, Calif., were investigated in a reconnaissance by H. W. Hoots. The Montebello-Santa Monica district, Los Angeles County, is being studied by Mr. Hoots, who has reviewed the work previously done by W. S. W. Kew and extended it westward to Topanga Canyon. The oil possibilities of certain areas in the southern part of San Joaquin Valley were discussed by Mr. Hoots in a press memorandum. Other reports completed or being prepared by Mr. Hoots include a paper on the oil possibilities of an area northeast of Petaluma, Sonoma County, and a brief paper entitled "Oil shale in a producing oil field of California." The geology of the Elk Hills oil field, including naval reserve No. 1, has been investigated by P. V. Roundy and W. P. Woodring, who are now preparing a report. A group of silver mines and prospects in the Panamint mining district were examined by F. C. Schrader for the Department of Justice. A geologic survey of the Ivanpah quadrangle was continued by D. F. Hewett in that part which lies in San Bernardino County. This work was undertaken primarily on account of the numerous ore deposits that have been exploited, but the region is yielding many structural data that will aid in studies near by. The quadrangle contains an exceptionally complete stratigraphic record as well as extensive areas of igneous rocks of two epochs. Preparation of a report on the Alleghany district was continued by H. G. Ferguson, who devoted a large part of his time to a detailed study of the mineralogy of the veins, in the hope of determining the principal factors that have controlled the deposition of the gold. The report on the resurvey of the Mother Lode district has been practically completed by Adolph Knopf. Deposits of iron ore near Amboy and Baxter and of fluorspar in southeastern California near Baxter were examined by E. F. Burchard, in connection with an estimate of the fluorspar reserves. Carboniferous invertebrate fossils were studied by G. H. Girty, and Jurassic invertebrates from the Mariposa shale and Eocene invertebrates from Mendocino County were identified by T. W. Stanton. Preparation of a paper on the physiography of the upper San Joaquin Basin was continued by F. E. Matthes. Papers on the borate deposits in the Kramer district, Kern County, and on a colemanite deposit near Shoshone, by L. F. Noble, were published during the year as Bulletins 785-C and 785-D. The San Andreas rift and some other active faults in the desert region of southeastern California are being studied by Mr. Noble, and a preliminary report was sent to the advisory committee on seismology of the Carnegie Institution of Washington. A station for volcanologic investigation was established at Mineral, to be known as the Lassen station, with R. H. Finch in charge.

COLORADO

The coal resources, structure, and stratigraphy of the Eastern Yampa coal field, Colorado, were investigated by M. R. Campbell, who is now preparing a report. Coal and oil shale along the Little Book Cliffs near Grand Junction, in western Garfield and Mesa Counties, were studied further by a party in charge of C. E. Erdmann, in order to connect the geologic mapping with that being done by D. J. Fisher on the Book Cliffs in Utah. The relations of the Mesaverde and Mancos formations in the valleys of White and Yampa Rivers and in the region between Rangely and Craig were studied by J. B. Reeside, jr., and E. M. Spieker, who are now preparing a report on the region. Studies of the Green River formation were continued by W. H. Bradley. A study of the mining geology of Colorado, in charge of B. S. Butler, carried on in cooperation with the Metal Mining Fund, was begun early in the year; the survey of the Montezuma quadrangle was begun by T. S. Lovering, and the mapping of the geology and study of the mines in the more productive part of the mineralized belt is well advanced. The study of the Breckenridge district was begun by B. S. Butler. The geology of the Bonanza district proved to be very complicated, and the study is not yet complete, though W. S. Burbank worked in the area for several months and Mr. Butler for several weeks.

A critical study of topographic and geologic mapping in the Mosquito Range was begun to determine the amount of revision necessary to meet present-day requirements for economic geology and to outline areas that should be mapped on a large scale. F. C. Calkins reviewed old mapping and did local detailed work in the Tenmile district, on the west side of the range, and reviewed the

mapping and examined mines and prospects in the Alma district, on the east side. Particular attention was given to the Mosquito fault and the highly faulted area at Kokomo. New developments of critical importance in the Leadville and Cripple Creek districts were studied by G. F. Loughlin, and conclusions already reached were verified. Mr. Loughlin continued the preparation of a preliminary report on deep levels in the Cripple Creek district. Reconnaissance study of the glacial geology and physiography of Sweetwater and Carbon Counties, Wyo., as a part of the general study of these problems in Wyoming and adjacent States, was extended into Routt County, Colo.

Material for the revision of the geologic map of Colorado was contributed to the Colorado Geological Survey, which will issue the map. The San Juan Mountains of southwestern Colorado contain valuable deposits of precious and other metals, thick series of volcanic rocks, and records of glaciation in the past. A comprehensive report on the volcanic and other rocks of the entire region is being prepared by Whitman Cross, E. S. Larsen, and C. S. Ross. As a product of the general investigation, a paper on the physiography of the San Juan Mountains has been prepared by W. W. Atwood and K. F. Mather and is now being reviewed preparatory to publication. A paper on a new gastropod genus from the lower Ordovician of Colorado, by Edwin Kirk, will be published in the Proceedings of the United States National Museum. Fluorspar deposits at Jamestown, Wagon Wheel Gap, and North Gate were examined by E. F. Burchard, who prepared a report on the fluorspar resources of Colorado and Washington for a committee of the Mining and Metallurgical Society. A report on the flora of the Denver formation, by the late F. H. Knowlton, was edited by E. W. Berry.

CONNECTICUT

A paper on the geology of the Taconic belt of western Connecticut and the adjacent portions of New York and southwestern Massachusetts has been prepared by Mrs. E. B. Knopf for publication in the American Journal of Science.

DISTRICT OF COLUMBIA

The age relations and suitability for foundations of gravel, sand, clay, and other kinds of rock as found in excavations in the city of Washington were studied by Arthur Keith and Laurence LaForge, who have frequently furnished data to engineers and contractors desiring information as to conditions likely to be encountered in proposed excavations and have also furnished information to the Supervising Architect's Office and to the Park and Planning Commission.

FLORIDA

For a revised report on the geology of Florida, prepared in cooperation with the Florida Geological Survey, C. W. Cooke conducted extensive field studies and is engaged in preparing a new geologic map and text. He was associated in the field with Stuart Mossom, assistant State geologist, and was assisted by W. C. Mansfield, who identified the fossils collected from the Miocene and later formations. A critical study of fossil shells found in the Choctawhatchee marl in the northwestern part of the State was continued by Mr. Mansfield, whose report will be published by the Florida Geological Survey. Beds containing human and other bones near Melbourne, on the east coast, and near St. Petersburg, on the west coast, which had been examined in cooperation with the Bureau of American Ethnology, were described by C. W. Cooke in a paper published in the American Journal of Science. Drill samples from an oil prospect well at Monticello, Fla., were studied by Mr. Cooke to determine the character and age of the rocks penetrated.

Four chapters of Professional Paper 142, on the molluscan fauna of the Alum Bluff group of Florida, by Julia Gardner, were issued.

GEORGIA

As an aid to future exploration and development of the marble deposits of the Tate quadrangle, in northern Georgia, which have been worked for many years, their complicated structural relations have been studied by Arthur Keith, in cooperation with W. S. Bayley, who is preparing a report on these deposits for the Georgia Geological Survey.

HAWAII

From the headquarters of the section of volcanology, T. A. Jaggar in charge, at Volcano House, Hawaii, on the rim of the crater of Kilauea, observations of the volcanic phenomena in the island group were made systematically. By cooperation with the Coast Survey, a precise-level line connecting tidewater at Hilo with the summit of Mauna Loa was run. From this line as a base, local level lines are extended from time to time to check the changes in altitude and the tilt in the land surfaces indicated by the seismographs. A set of shallow borings was begun on the floor of Kilauea crater to study the distribution of temperatures over this area. In cooperation with the Hawaiian Volcano Research Association four seismograph stations were maintained on the island of Hawaii, and publication of the Volcano Letter, a weekly leaflet about the activities of the Hawaiian volcanoes, and the monthly Bulletin, containing the scientific results obtained at the station, was continued.

IDAHO

Cooperation with the Idaho Bureau of Mines and Geology was continued through investigations by C. P. Ross, who furnished reports to the State organization on a disseminated-lead prospect in northern Boise County; the Vienna district, Blaine County; ore deposits in Tertiary lavas in the Salmon River Mountains; and the Deadwood district, Valley County. The detailed survey of the Casto quadrangle was also continued by Mr. Ross. In connection with a general study of the glacial geology and physiography of the region, W. C. Alden made a reconnaissance in Fremont County. An especially complete report describing the geography, geology, and mineral resources (principally phosphate) of southeastern Idaho, by G. R. Mansfield, with a discussion of the paleontology by G. H. Girty, was sent to the printer in January and will appear as Professional Paper 152. Mr. Mansfield also transmitted for publication a report on the geology and mineral resources of the Portneuf quadrangle and began another on the Paradise Valley and Ammon quadrangles. Small lots of Tertiary and Triassic invertebrates from Idaho were examined by W. C. Mansfield and T. W. Stanton. The gold placer deposits extending about 20 miles along Crooked River in the Banner district were examined by F. C. Schrader for the Department of Justice, in connection with an investigation of the properties of the Idaho Hydraulic Corporation. The Bellevue mining district was revisited by D. F. Hewett, with the geologist of the principal operating company, in order to revise the text of a geologic report on the district. Mr. Hewett also examined a manganese deposit near Cleveland, Bannock County, and prepared a brief report for publication. A brief reconnaissance of iron-ore deposits in northern Idaho was made by E. F. Burchard as a basis for any future plans that may be formulated in connection with a study of western iron ores.

ILLINOIS

Progress was made toward the completion of a geologic folio on the Equality and Shawneetown quadrangles, which lie partly in Illinois and partly in Kentucky. The investigation, conducted by Charles Butts, has been made in cooperation with the Illinois Geological Survey.

INDIANA

A report on the grading of Indiana limestone was prepared by G. F. Loughlin, who also visited southern Indiana in connection with the investigation of concrete aggregates. Outcrop material from Indiana was studied by P. V. Roundy during his studies in micropaleontology.

IOWA

Some of the coal deposits in Iowa were sampled by M. R. Campbell in connection with the classification of the Carboniferous coals of the Mississippi Valley.

KANSAS

A study of the oil and gas resources and possibilities of Kansas was continued in cooperation with the Kansas Geological Survey. Investigations in Cowley County were completed by N. W. Bass, and a map of the county was

compiled for publication by the State Survey. An extension of the work from Cowley County into Kingman, Sumner, Reno, Sedgwick, Rice, and Harper Counties was begun. Microfossils that have been collected from outcrops of rocks in the State and Carboniferous invertebrate fossils were studied by P. V. Roundy. Office work on the report on the Wyandotte quadrangle, with which the report on the Kansas lead and zinc mines will be incorporated, was continued by C. E. Siebenthal.

KENTUCKY

Progress was made by Charles Butts toward the completion of a geologic folio on the Equality and Shawneetown quadrangles, which lie partly in Kentucky and partly in Illinois.

LOUISIANA

In informal cooperation with W. C. Spooner and several other geologists of Shreveport, an attempt was made by Julia Gardner to determine the relation of certain of the geologic formations of Tertiary age of northern Louisiana to those of corresponding age in northeastern Texas. The presence in Louisiana of the Eagle Ford shale, a formation closely associated with the petroleum deposits of central Texas, was definitely determined through the examination of core samples from several wells in DeSoto, Red River, and Natchitoches Parishes by L. W. Stephenson. Well cuttings from the recently drilled Caster No. 1 gas well, in Monroe County, were examined by H. D. Miser and P. V. Roundy and were found to indicate that the gas sand is of Mississippian age. Invertebrate fossils from the Comanche formation from several deep wells in northwestern Louisiana were identified by T. W. Stanton, and Pleistocene mollusks from outcrops by W. C. Mansfield.

MAINE

Preparation of a folio describing the Portland and Casco Bay quadrangles, Maine, was continued by Laurence LaForge. The geology of the area is fairly simple but is important in that an understanding of it furnishes a key for the interpretation of the geology of much of southern Maine.

MARYLAND

Detailed study of the geology of Carroll and Frederick Counties, Md., was continued by A. I. Jonas in informal cooperation with the Maryland Geological Survey, which will issue the reports. Additional knowledge of several of the younger geologic formations of Maryland, Virginia, and North Carolina resulted from investigations by W. C. Mansfield, who prepared a paper entitled "Some peculiar fossil forms from Maryland," published in the Proceedings of the United States National Museum, and transmitted for publication "Notes on Pleistocene faunas from Maryland and Virginia and Pliocene and Pleistocene faunas from North Carolina."

MASSACHUSETTS

The Boston folio was completed and revised by Laurence LaForge. The Boston area is a striking example of a district in which some of the problems can not be solved from information obtained within the area, and the unraveling of its geology has required not only a detailed and laborious study of the area itself but years of careful work in a considerable surrounding area. The geology of southwestern Massachusetts has been studied by E. B. Knopf in connection with her investigation of the southern Taconic belt in this State and the adjacent portions of New York and Connecticut. A paper giving results of the investigation has been prepared for publication in the American Journal of Science. Further studies of a part of the Taconic belt in northwestern Massachusetts and the adjacent portions of Vermont and New York have been made by L. M. Prindle.

MICHIGAN

In informal cooperation with the Michigan Geological Survey a considerable part of the Paleozoic section of the State was studied by E. O. Ulrich, who also gave special attention to the Devonian fauna. Progress was made on the

description of the Carboniferous invertebrate fauna of the Marshall sandstone by G. H. Girty, who spent a few days in the field collecting fossils from selected localities.

MISSOURI

Studies of early Paleozoic stratigraphy and paleontology in Missouri, with special reference to the Cotter, Powell, and Proctor formations, were continued by E. O. Ulrich. Work was continued upon the report on the geology and ore deposits of the Wyandotte quadrangle, which includes a strip about 6 miles wide in the southwest corner of Missouri.

MONTANA

A study of metalliferous deposits in a region west and north of Helena, Mont., was begun by J. T. Pardee. A preliminary report issued as a press memorandum covers the Zosell (Emery), Scratch Gravel Hills, Towsley Gulch, Seven-up Pete Gulch, Gould, Stemple, and Heddleston districts. The results of Mr. Pardee's investigations of the Montana earthquake of June 27, 1925, were published in Professional Paper 147-B. He has in preparation a paper on late Tertiary and Quaternary faults in southwestern Montana. Progress was made toward the completion of a report on the geologic structure of the Bearpaw Mountains and the surrounding plains area, by Frank Reeves. The structural features are unique, for the circular mountainous area of Tertiary volcanic rocks occupies the crest of a domed area and is adjoined on the north and south by portions of the plains in which thrust faults lie concentrically arranged with reference to the mountains. Recommendations for drilling for oil and gas in the belt of faulted rocks south of the Bearpaw Mountains were discussed by Mr. Reeves in a press memorandum. The Kevin-Sunburst oil field and the Sweetgrass arch are described in a report prepared by A. J. Collier, and a report on the structure and oil possibilities in the plain adjacent to the Highwood Mountains, Mont., has been submitted for publication by Frank Reeves. Data of value in the search for oil in the plains around the Big Snowy Mountains were obtained by Mr. Reeves, who made a field study of the rocks in the mountains. Cretaceous invertebrates from the Sweetgrass arch and the Highwood Mountains and Jurassic invertebrates from the north end of the Big Horn Mountains were identified by J. B. Reeside, jr., and T. W. Stanton. The revised report by A. A. Baker on the northern extension of the Sheridan coal field was completed and submitted for publication. Reports on the Ingomar anticline and the Cat Creek and Devils Basin oil fields were published as Bulletins 786-A and 786-B.

NEVADA

A portion of the Carson Sink region, Nevada, was studied by F. C. Schrader to complete some investigations of the region begun several years ago. Most of the surface geology in the Chalk Mountain and Quartz Mountain districts was mapped and the stratigraphy studied. The mines and principal prospects in these districts and in the Gold Basin district were examined, and a preliminary report on the districts was prepared for publication. Mr. Schrader also examined the mines and prospects in the Contact district, where, since the construction of the railroad in 1925, extensive development work is being done on the copper deposits, which occur in a quartzite-limestone-shale series of upper Carboniferous age and are genetically connected with Cretaceous intrusive granodiorite and related rocks.

In connection with field work in the Ivanpah quadrangle, several mines in the Goodsprings district were revisited by D. F. Hewett, whose observations were embodied in a report on the district recently completed. The survey of the Pioche district was continued by L. G. Westgate, who mapped the surface geology of the Panaca quadrangle and the southeastern part of the Pioche Range. Edwin Kirk spent some time with Mr. Westgate in unraveling the Cambrian to Devonian stratigraphic section of the region. The economic geology of an area near Pioche was studied by Adolph Knopf, and a preliminary paper on the geology of the district was prepared by Messrs. Westgate and Knopf for presentation at the meeting of the American Institute of Mining and Metallurgical Engineers in New York City. The final report is in course of preparation. Detailed mapping of the Las Vegas quadrangle was continued by C. R. Longwell. Fossils collected by him were studied by Edwin

aper on the flora of the Esmeralda formation in western Nevada, erry, was approved for publication in the Proceedings of the United onal Museum.

NEW ENGLAND

quake, usually referred to as the St. Lawrence earthquake, which disturbed New Englanders on February 28, 1925, was but one, though vere, of a series of quakes that affected a large area in the north- lited States and Canada between July, 1924, and March, 1926. In the recording by seismographs, the St. Lawrence quake was noted an senses in an area of about a million square miles. The causes of the earthquake were investigated by Arthur Keith, who prepared dum for the press on this subject and presented a paper entitled rthquakes in New England" at the meeting of the eastern section of ogical Society of America at Boston in May, 1927.

NEW JERSEY

ts of the explosion at Lake Denmark, N. J., July 10, 1926, were l by G. R. Mansfield, at the request of and in cooperation with the rtment, to determine the possibilities of damage to property by ck. Glacial formations and attendant features in western New e studied by Frank Leverett, in cooperation with the New Jersey Survey. The Ordovician section in the Delaware Water Gap was E. O. Ulrich.

NEW MEXICO

th investigations of the year centered largely in New Mexico, where for core drilling, all in Eddy County, were selected and reported to of Mines as a part of the cooperative potash investigation authorized ral potash act, under which \$100,000 was appropriated for the fiscal Contracts were made for core tests at these sites, and the drilling hem was completed. The cores were delivered to the Geological study, and portions were selected for analysis. Preliminary reports he economic results of the work are in an advanced stage of prepa-e samples from a private potash test on the McNutt permit in S., R. 30 E., Eddy County, were submitted to the Geological Survey id analysis. Two press memoranda on the McNutt core test and the Mexico potash area were prepared by G. R. Mansfield. A paper on vestigations in 1924," by W. B. Lang, was published as Bulletin e Great Eagle fluorspar mine, near Lordsburg, was visited by ard in connection with a study of fluorspar reserves by a committee g and Metallurgical Society of America. The manuscript of a report a Rita district, by A. C. Spencer, is nearing completion.

NEW YORK

of several major problems in the part of the Taconic belt lying in n Vermont, eastern New York, and northwestern Massachusetts was y L. M. Prindle, who examined the Hoosick, Bennington, Berlin, nd adjoining quadrangles, between the parts of the Taconic belt en studied by Arthur Keith farther north in New York and Vermont . Knopf farther south in New York, Massachusetts, and Connecticut. n chart of the exposed formations of eastern New York and Vermont d by Arthur Keith in connection with his stratigraphic and struc- s of the Taconic area. Geologic results have been obtained in the onic area of eastern New York, western Connecticut, and south- ssachusetts. Although the geology of this area is complicated, much has been obtained on the stratigraphy, structure, and metamorphism

E. B. Knopf, who has worked on this problem, has written a paper me results of recent field work in the southern Taconic area," which lished in the American Journal of Science.

NORTH CAROLINA

uper on some Cretaceous fossils from North and South Carolina was L. W. Stephenson for publication in the Proceedings of the United onal Museum. Fossil shells were collected from several of the

younger geologic formations of the Coastal Plain by W. C. Mansfield and W. P. Popenoe. Some of the results of these studies are included in a paper by Mr. Mansfield entitled "Notes on Pleistocene faunas from Maryland and Virginia and Pliocene and Pleistocene faunas from North Carolina," transmitted for publication. A brief cooperative report on an unsuccessful oil-prospecting well near Havelock, prepared by Mr. Mansfield, was published by the North Carolina Department of Conservation and Development. One of the important facts recorded in this report is the depth to the crystalline bedrock (2,318 feet) which underlies the Coastal Plain formations. A field study was made of a portion of the proposed Great Smoky Mountains National Park of western North Carolina and eastern Tennessee by Arthur Keith in connection with his resurvey of parts of the Mount Guyot quadrangle.

NORTH DAKOTA

A paper on the Fox Hills and Lance formations in the northern Great Plains is being prepared by C. E. Dobbin and J. B. Reeside, jr.

OHIO

Preparation of a geologic folio on the Cleveland, Berea, and Euclid quadrangles, Ohio, by Frank Leverett, F. R. Van Horn, and H. P. Cushing, was continued. A structure contour map of the northern Appalachian region in portions of Pennsylvania, Ohio, and West Virginia was compiled by G. B. Richardson during his studies of oil and gas fields. The glacial deposits in eastern Ohio between East Liverpool and Kinsman were examined by Frank Leverett in connection with comprehensive glacial and physiographic studies in the older drift areas.

OKLAHOMA

The first colored geologic map of the entire State of Oklahoma ever published, prepared in cooperation with the National Research Council, the Oklahoma Geological Survey, and the geologists and oil companies of the State, was issued. The map is an important addition to the knowledge of the geology of the United States. It is on a scale of about 8 miles to 1 inch, measures 36 by 65 inches, and is printed in 22 colors, with 105 separate colored patterns. The map was compiled by Hugh D. Miser, chiefly from about 1,000 maps of parts of the State that were obtained from numerous sources, though he visited and mapped a few small areas. Unpublished as well as published maps were used—in fact, the new geologic mapping not heretofore published covers more than half the State. A revised edition of the map of the oil and gas fields, pipe lines, and refineries of the State was nearly completed under the supervision of G. B. Richardson. A field study has been made of the geology of the Ouachita Mountains of southeastern Oklahoma with a view to completing a report on the rocks and mineral resources. The study was made by Mr. Miser, in cooperation with the Oklahoma Geological Survey and with geologists of the State. A description of water-laid volcanic deposits of Upper Cretaceous age in the southeastern part of the State is contained in a report by C. S. Ross, H. D. Miser, and L. W. Stephenson, transmitted for publication. A paper on the age of the Carboniferous rocks of the Ouachita Mountains of Oklahoma and Arkansas has been written largely by H. D. Miser, in collaboration with C. W. Hones, formerly a geologist of the Oklahoma Geological Survey. A description of the fauna of the Moorefield shale by G. H. Girty and a study of its micro-fauna by P. V. Roundy are in progress. Sales of Osage leases at Pawhuska on September 30, 1926, and March 28, 1927, were attended by P. V. Roundy, at the request of the Office of Indian Affairs, to give advice concerning the adequacy of bids. A brief study of the geology of a portion of Osage County has been made by Mr. Roundy. A geologic study of the Stigler coal field was made by W. T. Thom, jr., to obtain information not only on the coals but also on the gas possibilities of the area. A report giving the results of the study has been prepared for the official use of the conservation branch. The Joplin region of Missouri, Kansas, and Oklahoma remains the most productive zinc-lead ore district in the United States. Office work on a report covering the richest portion of the region, near Picher, Okla., in the Wyandotte quadrangle, and in the adjoining part of Kansas, was continued by C. E. Siebenthal, who also prepared a contour map showing the subsurface from Cardin to Scammon Hill, with text discussing the principal features, chief of which is the Commerce trough.

OREGON

The Ladysmith iron-ore tract, the Pisgah tract, the tract of ore land of the Oregon Iron Ore Corporation, and the Bunker Hill tract in Columbia County, Oreg., were examined by E. F. Burchard. Methods and extent of prospecting and character of ore were noted, analyses were obtained, and studies were made of the possible markets for the ore.

PENNSYLVANIA

Geologic studies were made in different parts of Pennsylvania, largely in cooperation with the Pennsylvania Topographic and Geologic Survey. A cooperative report on the Lancaster quadrangle has been prepared by G. W. Stose, of the United States Geological Survey, and A. I. Jonas, for the Pennsylvania survey, and will be published by the State. A report on the geology of Adams County by Mr. Stose will be issued by the State. A geologic map of Pennsylvania, which is being compiled by the State survey, has been prepared in part by Mr. Stose. In the York, Middletown, and Hanover quadrangles field investigations have been continued by Mr. Stose and Miss Jonas, in cooperation with the State. The manuscripts for the geologic folios on the Somerset and Windber quadrangles, by G. B. Richardson, and on the Fairfield and Gettysburg quadrangles, by Mr. Stose and Florence Bascom, were completed. Progress was made on the New Kensington folio, by G. B. Richardson; the Bellefonte folio, by E. S. Moore and Charles Butts; and the Quakertown-Doylestown folio, by Miss Bascom and Mr. Stose. Several scientific papers relating to the above-mentioned work have been prepared for outside publication as follows: "Summary of the pre-Cambrian geology of Pennsylvania and Maryland," by A. I. Jonas and E. B. Knopf; "Ordovician shale and lava in southeastern Pennsylvania," by G. W. Stose and A. I. Jonas; "Tectonics of southeastern Pennsylvania," by G. W. Stose; "Possible post-Cretaceous faulting in the Appalachians," by G. W. Stose; "Ordovician shale of Pennsylvania," by G. W. Stose. The cooperative studies of glacial geology in Pennsylvania were continued by Frank Leverett, who investigated the relative ages of the deposits of the three glacial stages represented in northwestern Pennsylvania and the distribution and character of gravel deposits in valley trains laid down by water flowing from the ice front. These deposits constitute a valuable source of road material. Mr. Leverett also studied glacial formations and attendant features in eastern Pennsylvania. A structure-contour map of the northern Appalachian region in portions of Pennsylvania, Ohio, and West Virginia was compiled by G. B. Richardson in connection with his studies of oil and gas fields. Stone quarries in western Pennsylvania were visited by G. F. Loughlin, who conferred with highway engineers and others regarding the qualities of certain stone for concrete aggregates.

SOUTH CAROLINA

A description of the geologic section at Mars Bluff, Pee Dee River, S. C., a list of fossil shells, and the description of one new species from the same section are included in a paper entitled "Additions to the Upper Cretaceous invertebrate faunas of the Carolinas," by L. W. Stephenson, prepared for publication in the Proceedings of the United States National Museum.

SOUTH DAKOTA

The oil and gas possibilities of part of the region near Edgemont, S. Dak., were described by W. W. Rubey in a press memorandum. Well cuttings from the northern part of the State were examined by T. W. Stanton to determine the age of the rocks penetrated by the drill. The Fox Hills and Lance formations in the northern Great Plains are described in a paper which is being prepared by C. E. Dobbin in collaboration with J. B. Reeside, jr. Cretaceous fossil plants from the Black Hills were studied by F. H. Knowlton and E. W. Berry and invertebrate fossils from the same region by Mr. Reeside.

TENNESSEE

A field study was made of a portion of the proposed Great Smoky Mountains National Park in eastern Tennessee and western North Carolina by Arthur Keith. Western Tennessee is included in the Mississippi Embayment, a north-

ward extension of the Gulf Coastal Plain. The geologic formations of Tertiary age in this area have yielded large collections of beautifully preserved fossil plants, which are described and illustrated in a report by E. W. Berry, transmitted for publication. Early Paleozoic sections in eastern Tennessee were studied and paleontologic collections obtained by E. O. Ulrich, Charles Butts, and R. D. Mesler. The fauna of the Ripley formation on Coon Creek, Tennessee, is described by Bruce Wade in Professional Paper 137, and the ores of Ducktown by W. H. Emmons and F. B. Laney in Professional Paper 139.

TEXAS

Development of the petroleum resources of the Coastal Plain of central and northeastern Texas has emphasized the necessity for an exact knowledge of the oil-bearing and associated formations of that area, and several projects with that end in view were continued. Progress was made on the preparation of a cooperative geologic map of the State, and important additional knowledge was gained of the surface distribution and structural and stratigraphic relations of the Cretaceous and Tertiary formations. This work was carried on partly in cooperation with the Texas Bureau of Economic Geology and partly as independent projects, by L. W. Stephenson, Julia Gardner, and C. H. Dane. The final results will appear as maps and reports published by the Geological Survey and by the Texas Bureau. Mapping of large areas in west-central Texas, in preparation for the proposed geologic map of the State, was continued by N. H. Darton. The Comanche stratigraphy of the Edwards Plateau and adjacent areas was studied by T. W. Stanton in cooperation with Mr. Darton, and many collections of Comanche invertebrates were identified by Mr. Stanton. The fauna of the Cisco formation is being described by G. H. Girty, and other Carboniferous collections were studied by Messrs. Girty and Roundy. Potash investigations were continued in Texas chiefly by W. B. Lang, who watched oil-drilling operations, procured samples, and obtained data for the selection of drilling sites in Crockett and Ector Counties. A contract for drilling at the Ector County site was closed by the Bureau of Mines near the end of the year. Two press notices on the Texas-New Mexico potash area were prepared by G. R. Mansfield. The new edition of the oil and gas map of Texas compiled under the direction of G. B. Richardson was nearly ready for distribution at the end of the year. The map is printed in colors and shows oil and gas fields, oil pipe lines, salt domes, and refineries. A paper describing Upper Cretaceous water-laid deposits of volcanic materials in northeastern Texas, by C. S. Ross, H. D. Miser, and L. W. Stephenson, was transmitted for publication.

UTAH

The coal resources and oil possibilities of eastern and southeastern Utah were investigated by three parties under the field supervision of C. E. Dobbin, as follows: Mapping of the rock formations and topographic features of the canyon-trenched country lying between Colorado and Green Rivers was continued by a party in charge of E. T. McKnight; mapping of the rocks and topographic features of the rugged country adjacent to Colorado River near Moab was continued by A. A. Baker and assistants; and the investigation of the coal resources of the Book Cliffs was continued by D. J. Fisher and party. A final report on the Book Cliffs coal field is being prepared by Mr. Fisher. Some of the results that were obtained during the field season of 1926 by the McKnight and Baker parties have been embodied in a paper, "Notes on the stratigraphy of the Moab region," which will be published in the Bulletin of the American Association of Petroleum Geologists. The major geologic features were described in a memorandum to the press. The Wasatch Plateau coal field is described in a report by E. M. Spieker to be published as a bulletin. The rock formations and coal near Manti and the rocks in Round Valley were studied by Mr. Spieker. Fossil collections from Sanpete Valley were studied by J. B. Reeside, jr. The sedimentary rocks of the San Rafael Swell and some adjacent areas in eastern Utah are described in a report by James Gilluly and Mr. Reeside, transmitted for publication. The igneous rocks in the San Rafael Swell are described in two papers by Mr. Gilluly, of which one on the analcite diabase and analcite syenite was submitted for publication in a scientific journal. The Green River formation has been studied further by W. H. Bradley, who has completed two papers on the subject. One entitled "Algae reefs and oolites of the Green River formation" will be published by the

Geological Survey. Work on a report on the stratigraphy of the Green River formation in Colorado and Utah was continued. The coal and the possibilities for oil and gas in portions of Garfield and Kane Counties are described in a report by R. C. Moore. Further investigation has been made of the Cottonwood-American Fork district, which contains valuable deposits of silver, lead, copper, and some gold and a little zinc. The report on the ore deposits has been written by B. S. Butler; that on the general geology is being written by F. C. Calkins. Areal mapping with a study of the stratigraphy and ore deposits of the Stockton and Fairfield quadrangles, including the Ophir district, was continued by James Gilluly, in association with Edwin Kirk and George H. Girty in the stratigraphic studies. The Gold Hill and neighboring districts were studied by T. B. Nolan, who has in preparation a general report on the geology and ore deposits of the Gold Hill quadrangle and a paper on the structure and stratigraphy. Messrs. Kirk and Girty cooperated with Mr. Nolan in the study of the stratigraphy and paleontology. Some silver and lead mines and prospects occurring in Paleozoic limestone, shale, and quartzite in the Ashbrook district were examined by F. C. Schrader, who also investigated the relations of the Raft River Mountains uplift to that of the Contact district, Nevada. A paper on the Kaiparowitz region, by Herbert E. Gregory and Raymond C. Moore, a region which has long remained geologically unknown and within which surveys were needed for the correlation of strata and structure described in surrounding areas, was transmitted for publication. Cycads in the Shinarump conglomerate of southern Utah were described by E. W. Berry in a paper that appeared in the Journal of the Washington Academy of Sciences. Fluorspar deposits near Ogden were examined by E. F. Burchard. A report on the potash-bearing brines of the Great Salt Lake Desert, prepared by T. B. Nolan, was published as Bulletin 795-B.

VERMONT

Stratigraphic and structural studies of the Taconic area in Vermont were continued by Arthur Keith, and studies of a part of the Taconic belt in southwestern Vermont, eastern New York, and northwestern Massachusetts by L. M. Prindle.

VIRGINIA

Field investigations for a geologic map of Virginia were continued in cooperation with the Virginia Geological Survey, work being done in a portion of the Appalachian Valley belt by Charles Butts, of the Federal survey, and in the Piedmont belt by A. I. Jonas for the State survey. Structural conditions in the vicinity of Early Grove were found favorable for the possible accumulation of oil and gas in commercial quantities, and a report on the locality by Mr. Butts has been published by the State survey. A report describing a series of fensters along the Pine Mountain overthrust has been prepared by Mr. Butts and will be published by the State survey. A reconnaissance investigation in the vicinity of Bremono Bluffs was made for the State survey by G. W. Stose. E. F. Burchard conferred with officials of iron companies and examined iron-ore deposits in Alleghany, Bland, Botetourt, Craig, and Washington Counties, in cooperation with the Virginia Geological Survey, for the purpose of reviewing the present conditions affecting the iron industry in the State. Investigations of some of the younger formations of the Coastal Plain were continued by W. C. Mansfield, who completed a paper on the Miocene stratigraphy of Virginia and another paper containing descriptions of Pleistocene faunas from Virginia. Mr. Mansfield also reported on small collections of Miocene fossils obtained by C. K. Wentworth northeast of Richmond.

WASHINGTON

The Latah formation in the neighborhood of Spokane, Wash., a considerable flora from which had previously been described by F. H. Knowlton, was studied by him in the field and additional collections made. The new species in these collections and in others received from the Spokane Museum were described by E. W. Berry. Collections of fossil plants were obtained from the Puget formation by Mr. Knowlton in cooperation with R. W. Chaney, and the description of the Puget flora was in progress at the time of Mr. Knowlton's death. November 22, 1926, and has since been continued by E. W. Berry. Deposits of iron ore in eastern Washington and of fluorspar at Keller were examined by

E. F. Burchard, who prepared a report on the fluor spar reserves of Washington for a committee of the Mining and Metallurgical Society. J. T. Pardee examined dam sites on Skagit River for the water-resources branch. A short paper on the platinum deposits of Washington was prepared by Mr. Pardee, and his report on manganese-bearing deposits near Lake Crescent and Humptulips was issued as Bulletin 795-A.

WEST VIRGINIA

A structure-contour map of the northern Appalachian region in portions of West Virginia, Ohio, and Pennsylvania was compiled by G. B. Richardson in connection with his studies of oil and gas fields. Glacial and associated physiographic deposits in the Ohio Valley region of West Virginia were studied by Frank Leverett.

WISCONSIN

Progress was made in the office review of a report on the Sparta and Tomah quadrangles, in the Driftless Area of Wisconsin, prepared by F. T. Thwaites, W. H. Twenhofel, and Lawrence Martin under a cooperative agreement with the Wisconsin Geological and Natural History Survey.

WYOMING

A report on the Black Hills region of Wyoming and South Dakota that will be of special value to those who prospect the region for oil and gas has been partly completed by W. W. Rubey in connection with his studies of the geology and certain structural features of the rim of the Black Hills, and a paper on some of the structural features of the Black Hills has also been partly written. A paper entitled "Origin of the siliceous Mowry shale in the Black Hills region" has been transmitted for publication. A paper entitled "Possible natural soda drive in the Salt Creek type of pool, and its significance in terms of increased oil recoveries" was presented by W. T. Thom, jr., before the petroleum division of the American Institute of Mining and Metallurgical Engineers at Tulsa, Okla., October 12, 1926. Two papers on Wyoming oil fields—"The geology of the Rock Creek oil field and adjoining areas in Carbon and Albany Counties," by C. E. Dobbin, H. W. Hoots, C. H. Dane, and E. T. Hancock, and "The geology and coal and oil resources of the Hanna and Carbon Basins, Carbon County," by C. E. Dobbin, C. F. Bowen, and H. W. Hoots—have been submitted for publication. A report which describes the geology and the oil, gas, and coal resources of the southwestern part of the Big Horn Basin, covered by the Oregon Basin, Meeteetse, and Grass Creek Basin quadrangles, by D. F. Hewett, was issued as Professional Paper 145. The geology of the coal fields of Wyoming is treated in a summary paper written by Mr. Dobbin for publication in the series of technical papers of the Bureau of Mines. A paper on the Fox Hills and Lance formations of the northern Great Plains was partly written by Mr. Dobbin in collaboration with J. B. Reeside, jr. A paper on the algae reefs and oolites of the Green River formation of Wyoming and the adjacent parts of Colorado and Utah was completed by W. H. Bradley. A geologic examination of the south end of the Little Snake River coal field, Wyoming and Colorado, was made by M. R. Campbell and J. B. Reeside, jr. Asphalt deposits near Baggs were examined by E. M. Spieker, and the preparation of a report on them was begun. Field and office studies of the physiography and glacial geology of Sweetwater, Carbon, Albany, Natrona, Lincoln, and Fremont Counties, the Fort Washakie Reservation, and Yellowstone National Park were continued by W. C. Alden. Inspection of the iron-ore deposits in the Seminoe Mountains was completed by E. F. Burchard, accompanied part of the time by T. S. Lovering. A report on these deposits is in course of preparation by Mr. Lovering. A report entitled "Earthquakes in the Big Horn Mountains, Wyoming," was prepared by J. T. Pardee for publication in the Bulletin of the Seismological Society of America.

FOREIGN

A monographic study of Miocene mollusks from Bowden, Jamaica, carried on in cooperation with the Carnegie Institution of Washington, was completed by W. P. Woodring, and the second and final volume of his monograph on these

fossil shells was transmitted to the institution for publication. The first volume was published in 1925. Collections of late Tertiary fossils from Jamaica, submitted by Dr. C. A. Matley, former Government geologist of Jamaica, were reported on by Mr. Woodring.

The first reported occurrence of rocks of Eocene age on the south slope of the Andes in the State of Zamora, Venezuela, was recorded by W. P. Woodring in the Bulletin of the American Association of Petroleum Geologists, as the result of a study of material collected and submitted by N. H. Darton. Cretaceous and Tertiary invertebrates collected by Mr. Darton in Venezuela were identified by J. B. Reeside, jr., and Mr. Woodring.

A paper on tectonic features of the Caribbean region was prepared by W. P. Woodring for presentation at the Pan-Pacific Science Congress in Japan.

A paper entitled "A reexamination of the lead sulphosalt keeleyite from Bolivia" was written by M. N. Short and Earl V. Shannon for the American Mineralogist.

A paper entitled "Additional data on the properties of pumpellyite and its occurrence in the Republic of Haiti, West Indies," was prepared by W. S. Burbank for the American Mineralogist.

An upper Ordovician fauna from the Rocky Mountains of British Columbia was described by Edwin Kirk.

WORK IN CHEMISTRY

The work in chemistry comprised the partial and complete analyses of rocks and other geologic products, the identification and analyses of minerals, the study of geochemical problems, and researches in mineralogical chemistry. During the year 7,142 specimens were examined; 2,874 were identified for persons not connected with the Geological Survey, and 4,268 were chemically or mineralogically examined to furnish data for use in connection with problems being studied by Geological Survey members.

More time was spent on the chemical and mineralogical study of the potash salts of the Texas-New Mexico field than on any other one subject, 3,055 samples taken from wells being drilled for oil in this field having been examined. As a result of these tests a well sponsored by private interests was drilled in search for potash about 20 miles east of Carlsbad, N. Mex., and the owners of the well generously furnished the Geological Survey with a quarter section of selected portions of the core. The analysis and study of this material indicated a promising prospect for a commercial deposit of potash in this area. Thirty-five strata ranging in thickness from 10 inches to 4 feet were encountered which contained from 12 to 18 per cent of potash (K_2O). One stratum which was particularly promising consisted of two 3-foot layers containing 15 per cent of potash, separated by only 30 inches of rock salt. Polyhalite, a potassium-calcium-magnesium sulphate of remarkable purity, was found in a number of the strata. One 18-inch layer containing langbeinite, a rare potash mineral, was found at the 1,430-foot level. Several of the thicker potash strata were composed of sylvinite, a mixture of potassium chloride (sylvite), and rock salt. Other minerals identified in this core were kainite, kieserite, anhydrite, and magnesite. This is the first occurrence noted of kainite and langbeinite in the American continent.

The cores from the first two wells drilled for potash under the appropriation made by Congress for investigating potash deposits, 1927, were received and are now being chemically and mineralogically examined by R. K. Bailey, E. P. Henderson, W. T. Schaller, E. T. Erickson, and J. J. Fahey.

Radioactive minerals were studied with special reference to the determination of their geologic age by means of the lead-uranium ratio by R. C. Wells, in cooperation with the National Research Council's committee on the estimation of geologic time by this method. M. F. Connor, formerly chemist in the Geological Survey of Canada, collaborated as guest chemist during May and June, 1927, in studying analytical methods best suited for the separation and determination of lead, thorium, and uranium, the elements on which the estimate of age depends. Mr. Wells also wrote papers on evaporation from Chesapeake Bay and the element "mosandrum" of J. Lawrence Smith.

A minute study of polyhalite and other minerals of the Texas-New Mexico salt field, including a research into their origin, was made by W. T. Schaller. He also conducted laboratory and field investigations on the study of the origin of pegmatites and described in an article published in the *American Mineralogist* a new commercial boron mineral, called kernite, from California.

A bibliography and description of chemical work done during the year having a bearing on the problem of sedimentation was prepared by George Steiger for the committee on sedimentation of the National Research Council. Experimental laboratory work on the disintegration and solubility of Indiana limestone was also done by Mr. Steiger.

The problem of the formation of hydrocarbons from plant and animal remains was studied experimentally by E. T. Erickson, who also did some work on the separation of small quantities of the platinum group of metals.

WORK IN PHYSICS

Investigations of deep-earth temperatures and molecular geophysics occupied most of the time of the two physicists.

In the investigation of deep-earth temperatures C. E. Van Orstrand completed a summary of observations made in foreign countries and prepared memoranda for the press on the subject of the utilization of the earth's internal heat and the possible use of temperature measurements in prospecting for oil. A somewhat extended paper on the "Interpretation of earth temperatures" was published in the *Oil and Gas Journal*. In the absence of the usual allotment for field work, the National Research Council supplemented the work of the Geological Survey by the appointment of three research associates, one each at the Universities of Oklahoma, Texas, and California. During February and March Mr. Van Orstrand visited each institution, the field expenses being paid by the council, for the purpose of giving advice and instruction in regard to the construction of the necessary apparatus and the method of procedure in making the observations. Some work was done in the field of mathematical statistics relative to the representation and interpretation of petroleum production curves and the mathematical representation of the distribution of grain diameters of a sand. A paper entitled "Mathematical representation and interpretation of petroleum production curves" was published in the *Oil and Gas Journal*, and a short paper on the analytical and graphic representation of the arithmetic, geometric, and other means was completed.

In the field of molecular physics P. G. Nutting continued his work on the physical properties of silts and sands related to the recovery of petroleum in spent fields, held two conferences with operators in the Bradford field of Pennsylvania on field tests of the soda and other processes of petroleum recovery, investigated the fundamental laws governing adhesion and movement of fluids through porous solids, made numerous tests of sands and silts, developed improved test methods, answered numerous inquiries relating to the soda process, and published a number of papers bearing on these and related subjects. The results of the first field tests of the soda process for petroleum recovery, initiated in the summer of 1925, have been so encouraging that two of the leading producers have for some time been putting soda in all their recovery wells, and three others are now preparing to do so. These and other producers have constantly called on Mr. Nutting for advice as to the best concentration and amount of solution to use, the rate of introduction into the wells, the best backing pressure, and other problems concerned in the development of the field technique of the process. Many special problems have been solved in the physical laboratory, including the effect of carbonates and sulphates in the sands and of coatings of oxides and silicates on the sand grains on the movement of oil and soda solutions through them. To forestall innumerable inquiries three general papers were prepared—one on the best field practice, one on the physical and chemical principles underlying the process, and one on the development of the soda process, the results of field tests, and the patent situation to date.

An intensive study has been made of the forces of adhesion and adsorption between liquids and solids and between solids wet with liquids. Molecular physics in general, and selective adsorption in particular, are the keys to many important geologic changes, and a good beginning is being made in uncovering fundamental principles and data.

A small amount of office space in the physical laboratory has been assigned temporarily to F. C. Weaver, who is conducting an investigation, under the auspices of the National Research Council, on the thermal conductivity of gases. The investigation has for its object the determination of certain fundamental constants which when determined will provide a simple means of gas analysis, including the determination of the gaseous products of combustion, the gaseous content of rocks and minerals, and in particular the helium and hydrocarbon content of the natural gases found in the oil fields.

ALASKAN BRANCH

PHILIP S. SMITH, Chief Alaskan Geologist

FUNDS

The funds used by the Geological Survey in its Alaska work are provided in two items in the general act making appropriations for the Interior Department. One of these items reads, "for continuation of the investigations of the mineral resources of Alaska * * *." In this act for the fiscal year 1926 the amount was \$72,000; for 1927, \$50,000; for 1928, \$60,000. Each of these appropriations was

available immediately on the passage of the act in which it was contained. The other item is an allotment made from the appropriation "for the enforcement of the provisions of the acts of October 20, 1914, October 2, 1927, February 25, 1920, and March 4, 1921, and other acts relating to the mining and recovery of minerals on Indian and public lands and naval petroleum reserves * * *." Allotments under this item are available only during the fiscal year specified. In the fiscal year 1927 the allotment for this kind of work in Alaska was \$19,500. The two types of work indicated will be described for conveniences as the mineral-resources work and the mineral-leasing work.

MINERAL-RESOURCES WORK

Expenditures during the fiscal year beginning July 1, 1926, to June 20, 1927, from the 1926-27 appropriation may be distributed among the following major heads:

Expenditures from funds appropriated for mineral-resources investigations in Alaska for the fiscal year 1927

Projects, season of 1926.....	\$6,150
Projects, season of 1927.....	6,815
Administrative salaries.....	4,375
Other technical salaries.....	24,160
Other clerical and drafting salaries.....	6,565
Office maintenance and supplies.....	1,935
	<hr/>
	50,000

Only the amounts expended from the appropriation for 1927 are tabulated above, but most of the projects included in the item for the season of 1926 were started in the previous fiscal year, and \$16,735 was put into the start of these projects from funds carried in the appropriation for 1926. Similarly only a beginning of the projects included in the item for the season 1927 was made during the fiscal year 1927, and \$18,485 additional has been allotted from the appropriation for 1928 to complete them. These items do not include any charge for the technical services of the personnel assigned to these field projects and paid from the appropriation for 1927. Of this amount \$19,630 was for the technical services of the personnel assigned to the projects of 1926 and \$4,530 for those assigned to the projects of 1927. In addition technical salaries to the extent of \$6,080 were paid from the appropriations for 1926 for the projects of 1926, and an amount estimated at \$19,685 will be required from the appropriations for 1928 to complete the projects of 1927.

PRINCIPAL RESULTS OF THE YEAR

The principal results of the field investigations during the year have been the mapping both geologically and topographically of about 7,250 square miles of country. All of this except 350 square miles is country that had not been hitherto surveyed. The 350 square miles represents mapping in more detail of country that had hitherto been mapped on a much smaller scale on only exploratory standards. The following table indicates the area covered by surveys that have

been made in Alaska up to the present time by the Geological Survey. No report is made for the field season of 1927, because all the parties are out of communication, and it is not practicable to give the precise area surveyed up to the end of the fiscal year. This, however, is offset for all practical purposes, because for the field season of 1926 all of the area surveyed is reported, even though the work in it was commenced in the fiscal year 1925. In this way the amount of work done in the fiscal year 1926 on projects of 1926 presumably balances the amount of work that was done on the projects of 1927 during the fiscal year 1927.

Areas surveyed by Geological Survey in Alaska, 1898-1926, in square miles

Field season	Geologic surveys			Topographic surveys		
	Exploratory (scale 1:500,000, 1:625,000, or 1:1,000,000)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)	Exploratory (scale 1:500,000, 1:625,000, or 1:1,000,000)	Reconnaissance (scale 1:250,000, 200-foot contours)	Detailed (scale 1:62,500, 25, 50, or 100-foot contours)
1898-1925.....	75,500	154,505	5,977	55,980	190,150	4,066
1926.....	-350	7,250	-----	-350	7,250	-----
	75,150	161,755	5,977	55,630	197,400	4,066
Percentage of total area of Alaska.....	41.1			43.5		

In this table only the net areas surveyed are listed in the appropriate columns and there is no duplication of areas under "Geologic surveys" or under "Topographic surveys," although of course there is duplication between these two sets of surveys, the geologic and topographic work having been done in substantially the same areas. In other words, when a map on a reconnaissance standard, for example, includes an area formerly mapped on an exploratory scale, the entire area is included in the column of reconnaissance surveys and the appropriate amount is deducted from the area previously reported as having been mapped on an exploratory scale. It is for this reason that a deduction is shown in the column for exploratory surveys. The necessity for remapping some areas on a more detailed scale is apparent. For many areas in Alaska exploratory mapping is all that is warranted for some time. For others it has been necessary to do the more rapid and less expensive exploratory work to meet urgent demands for immediate information, with the intention that in selected areas or as funds and personnel could be made available the more detailed surveys would be made. Even a reconnaissance survey is entirely inadequate for many types of investigation, and unquestionably more detailed maps and reports should be undertaken in the areas that are of economic importance. The fact, therefore, that at present a little more than two-fifths of Alaska has been mapped on some scale does not tell the entire story. Much of the area now covered only by exploratory surveys should be resurveyed on a reconnaissance scale, and some of the area mapped on a reconnaissance scale should be remapped on a detailed scale. The inadequacy of information on which to base sound business enter-

prise in a region where the best maps available are on a scale of 4 miles to the inch is apparent not only to engineers but to all business men. At the rate at which the work is now being conducted it will be more than half a century before maps on even exploratory or reconnaissance scales will be available of those parts of the Territory that hold promise of commercial development.

PUBLICATIONS

During the year seven Alaskan reports have been issued. Thirteen reports that have been completed by the authors and approved for editing or printing are now in various stages of publication. Six reports are in active course of preparation, and several other reports have been begun, but additional field work will be required before their completion, and the time of publication is remote.

PROJECTS OF THE SEASON OF 1926

The projects carried on during the season of 1926 were distributed through all parts of the Territory and dealt with a wide range of subjects connected with the development of the mineral resources of Alaska.

Approximate cost and distribution of work for the field season of 1926

Region	Appropriation for 1926		Appropriation for 1927		Total
	Expenses	Salaries	Expenses	Salaries	
Southeastern Alaska.....	\$450	\$575	\$1,140	\$3,815	\$5,980
Copper River.....			210	640	850
Alaska Range.....	4,300	1,085	1,085	6,395	12,865
Yukon.....	4,115	800	1,815	3,150	9,880
Northern Alaska.....	7,870	3,620	1,400	3,840	16,730
General.....			500	1,340	1,840
Mineral resources.....				* 1,925	1,925
	16,735	6,080	6,150	21,105	50,000

* Includes \$1,475 clerical salaries.

The work in southeastern Alaska was all related to the airplane mapping of that region that was carried on in 1926 by the Navy Department in response to a request from the Geological Survey. The items listed in the foregoing table do not include \$7,000 that was turned over to the Navy from an earlier appropriation for the necessary photographic supplies, nor does it include any of the expenditures made by the Navy. It includes only the salary and expenses of the Geological Survey representative, R. H. Sargent, topographer, who accompanied the expedition, and certain of the office expenses and salaries connected with printing the films and preparing them for use in map compilations from the pictures. This work was continued during the entire winter, and an additional allotment from the funds for projects of 1927 was made for it. The Navy expedition accomplished noteworthy results, and the wholehearted cooperation of the many Government organizations that made this work a success is gratefully acknowledged.

The work in the Copper River region was of a general character and was directed principally toward the determination of the conditions under which the copper deposits of that area occur. This work was done by Fred H. Moffit in the course of the general investigations of the mineral resources of Alaska.

Combined geologic and topographic surveys were made on the eastern flanks of the Alaska Range in the vicinity of Skwentna River by a party in charge of S. R. Capps, geologist, and K. W. Trimble, topographer. Through cooperation

with the Alaska Railroad the transportation of the party from Anchorage to the mouth of Skwentna River was facilitated, and through the generosity of William N. Beach, who supplied an extensive pack train at a merely nominal charge, the cost of the work was reduced about \$4,000. No new areas of mineralization were discovered, but the geologic observations brought to light many data on the history of the region, and the topographic work affords reconnaissance maps of over 1,000 square miles.

North of Yukon River, in the unmapped valley of Sheenjek River, a combined geologic and topographic party in charge of J. B. Mertie, jr., geologist, with J. O. Kilmartin, topographer, did reconnaissance mapping. Unfortunately, one of the camp assistants was injured in the course of the work, so that it was necessary to make a short season and return to Fort Yukon for medical attention. In spite of the early close of this work about 1,200 square miles of hitherto unsurveyed country was mapped, and its principal geologic features were determined.

The work in northwestern Alaska was a continuation of the surveys first started in 1923, principally at the request of the Navy Department and at that department's expense, to determine the possibilities of petroleum in naval petroleum reserve No. 4. Although the Navy Department decided not to allot any more money to that work for the season of 1926, there were many points concerning the geology of the reserve and contiguous area that the Geological Survey felt required further examination before its task of exploring the region could be considered reasonably complete. A party consisting of Philip S. Smith, geologist, and Gerald FitzGerald, topographer, left for this region in February, 1926, and continued work there until late in August, when the last vessels which could be counted on for transportation left for the season. As a result of this work the geology and topography of an area of about 5,000 square miles was surveyed. Although this project cost more than any of the others that were undertaken in the season of 1926 and was in a most inaccessible region, where costs might be expected to be especially high, the extremely long season that was utilized and the consequently greater area covered made the unit cost of the work unusually low.

The work here grouped under general investigations includes a number of special studies. Among these may be mentioned the work done by F. H. Moffit relating to the general situation of the mineral industry in Alaska with a view to assisting in keeping track of the new work in progress and determining places in which further surveys would be most likely to bring productive results. Paleobotanic studies were made by C. A. Hollick with the aim of assisting the geologist in the correlation of coal-bearing beds in northern Alaska. Studies were made by J. B. Mertie of the igneous rocks which are in many regions the source of mineralization that has produced deposits of commercial value. In addition Mr. Mertie spent considerable time in the revision of a manuscript covering earlier work in northern Alaska.

In connection with the study of the Silurian fauna two new genera have been described by Edwin Kirk, in a paper to be published in the Proceedings of the United States National Museum. The description of the Permian fauna has been begun by G. H. Girty. Later Mesozoic invertebrates from northern Alaska were identified by J. B. Reeside, jr., and Triassic invertebrates from northern Alaska and Chitina Valley by T. W. Stanton.

Although no direct field expenditure is incurred for the collection of data on the production of minerals and ores, all the field geologists and engineers of the Geological Survey who are engaged in Alaskan work contribute much material as a by-product that would require the expenditure of several thousand dollars if the same data were collected as a separate investigation. As it is, the only expense of this work is part of the time of a clerk and about a month of the time of the chief Alaskan geologist. The result of this annual canvass of the mineral industry is a preliminary estimate of the production for the calendar year, issued on the succeeding January 1, and a more complete report issued as soon thereafter as final figures for the mineral production are available.

PROJECTS FOR THE SEASON OF 1927

The projects undertaken during the field season of 1927 have been under way only a short time at the end of the fiscal year, and all the parties are out of touch with any ordinary means of communication, so that it is not possible to make a detailed statement of the work actually accomplished during the fiscal year or the

precise cost of the work. The following table, however, sets down in summary form the areas in which the work is being done, the amounts allotted to the field work, and an estimate of the amounts for salaries that will be required for the surveys and for the necessary office work in completing for publication the maps and reports that will be prepared as an outcome of that work. In estimating the salaries it has been assumed that the work will be completed by the 1st of May, so that the field personnel will be available to start on the field projects of 1928 by that time; otherwise approximately \$3,700 additional for technical salaries will be required.

Approximate cost and distribution of work for the field season of 1927

Region	Appropriation for 1927		Appropriation for 1928		Total
	Expenses	Salaries	Expenses	Salaries	
Copper River.....	\$575	\$575	\$1,925	\$3,070	\$6,145
Alaska Peninsula.....	1,800	1,445	6,200	8,170	17,615
Yukon.....	4,250	2,510	2,750	6,420	15,930
Airplane map compilation.....			6,800		6,800
General.....	190		810	1,575	2,575
Mineral resources.....				* 1,950	1,950
	6,815	4,530	18,485	21,185	51,000

* Includes \$1,500 for clerical services.

The projected work in the Copper River region has been planned to gather data regarding the geology of part of the Nizina and Chitina Valleys. Only a small party, in charge of F. H. Moffit with one camp hand, has been assigned to this work. This survey is necessary to correlate certain of the investigations that have been made in the region in earlier years, and to supplement those more general observations by studying certain areas in greater detail and by visiting new areas. All these studies are directed toward solving the geologic conditions relating to the formation of the copper ores of the district, and aiding in determining the geologic history of that part of Alaska. Mr. Moffit will also collect data regarding the general development of the mining industry in the Copper River region and will visit such operating mines as time and other conditions permit.

In the Alaska Peninsula the work planned is practically a continuation of the surveys made at the head of Skwentna River in the season of 1926. A combined geologic and topographic party in charge of S. R. Capps, geologist, with R. H. Sargent, topographer, left in May to carry on this work. The party planned to land on the west side of Cook Inlet and to survey the route westward to the mountains. On reaching the mountains connection with the surveys of 1926 will be effected if practicable, and the rest of the season will be spent in covering as much of the unmapped area as time and other conditions permit. This is a region about which practically nothing is known except that there is a broad lowland between the coast of Cook Inlet and the foothills, west of which are high, rugged mountains, many of which support glaciers. It is believed that mineralized rock similar to that found in other points along the Alaska Range may also occur in these mountains. Part of the lowlands are undoubtedly underlain by coal beds.

Geologic and topographic surveys to cover parts of the unexplored region north of the Yukon have been approved. These surveys will connect with the earlier surveys made in part of the Chandalar River valley and will be carried through as much of the country to the north and east as practicable, so as to join with the surveys made in the season of 1926 on Sheenjek River. In order to take advantage of the better traveling conditions that are found before the snow disappears, Gerald FitzGerald, topographer, left in February to go by the usual routes to Fairbanks, and thence overland to Fort Yukon, where he procured the necessary supplies for a six-months field season. According to the plans Mr. FitzGerald and the outfit were then to proceed over the snow to a suitable place on the East Fork of Chandalar River and thence to distribute the supplies in convenient caches for use during the summer. With the opening of navigation J. B. Mertie, jr., geologist, in charge of the

party, went by the usual routes down the Yukon and after picking up supplies and equipment at Fort Yukon proceeded up Chandalar River to join Mr. FitzGerald. The region is so little known that no forecast of what the party will find in it can yet be made, but presumably parts of the region are mineral bearing.

Work on the task of compiling maps from the airplane pictures taken by the Navy Department has been kept continuously under way, and an additional allotment has been made from the appropriation for 1928 to cover the cost of preparing the photographs and taking from them the essential data to be incorporated in the maps.

The only work of a general character that was to be done in the field season of 1927 is a general survey of the mineral industry, especially in the southwestern part of Alaska. This work was assigned to Philip S. Smith, who left Washington June 26 to study certain of the mining camps in Seward Peninsula and along the southwestern part of Yukon River.

SALARIES AND OTHER EXPENDITURES

The item for other technical services includes all payments made for salaries of the permanent technical force of geologists and engineers. It covers all time spent on various projects, exclusive of administrative duties.

There has been a material reduction in the technical personnel employed during the season of 1927. This has been caused by the small amount of funds available, which has made it necessary to dispense with all but two topographers. Even a further reduction in field activities would have been required had not a furlough of five months been granted to one of the topographers. The curtailment resulted in setting free some funds, but was probably a greater loss to the Government than the total saving, because important work had to be laid aside or handled less efficiently by others not so conversant with the details, all of which took more time and gave less sure results. Furthermore, the necessity for all the highest-grade men doing many minor jobs because of the virtual elimination of assistants of lower grades and salary slowed up the work and doubtless made the unit cost higher.

The item for administrative salaries covers only those salaries that are related to the administration of the branch as a whole. The amount expended for administration is unusually low because, owing to the shortage of funds, it has been necessary to eliminate as much administration as possible and use the customary administrative officers on field projects.

All the clerical and drafting work is performed by one chief clerk, one assistant clerk, and one draftsman. Part of the time of the chief clerk, Miss L. M. Graves, was spent in branch administration. About three-fourths of the time of the assistant clerk is devoted to the preparation of the statistical inquiries relating to the annual mineral production of the Territory and tabulating and computing the results from the replies to these inquiries. The clerical personnel is entirely too small to handle the large volume of work, so that only the most pressing matters can be attended to, and many jobs that might better and more cheaply be done by a clerk must now be done by the technical members rather than incur the otherwise inevitable delay.

The miscellaneous expenses for the operation of the branch are comparatively small and do not include any items directly required in connection with the field projects, such as equipment and supplies, which are charged directly against the specific projects for which they are bought.

MINERAL-LEASING WORK

The mineral-leasing work in Alaska was conducted from an allotment of \$19,500 from a separate item in the appropriation for the Geological Survey. In order that the policies and practices that have been developed for handling the much larger volume of similar work in the States should be maintained so far as they are applicable or appropriately modified to meet Alaskan conditions and in order to utilize the existing agency that is conversant with Alaskan affairs, the general administration of the leasing work in Alaska rests jointly with the conservation branch and the Alaskan branch. For

the conduct of the field work an office is maintained at Anchorage, Alaska, in charge of B. D. Stewart, supervising mining engineer, with a staff of two other engineers, together with the necessary clerical assistance. During the fiscal year 1927 the following was the approximate distribution of funds expended by this office:

Administrative salaries-----	\$3, 500
Other technical salaries-----	12, 000
Clerical salaries-----	1, 500
Field and office expenses-----	2, 500
	<hr/> 19, 500

Much of the time of the administrative officer in Alaska is given to field work and other duties not regarded as strictly administrative in character, so that only a proportional part of the salary is charged as a direct administrative expense and the rest is included in the item "Other technical salaries."

The principal leasing activities during the year centered around the coal-mining operations along the line of the Alaska Railroad in the Matanuska and Healy River fields. Here the work of the Federal engineers served not only to take care of the Government's direct interest in its various leases but also to assist the operators with sound technical advice, which enabled them to solve some of their problems and was thus of indirect benefit to the Government and the mining industry. Investigations were also made during the year in the Porcupine region, Hyder district, and part of the Ketchikan region of southeastern Alaska; in the Teikel region, north of Valdez; in the Port Wells district and other parts of the country adjacent to Prince William Sound; in the Kenai district; in the vicinity of Fairbanks; at many places in the Kuskokwim Valley; and in most of the mining districts of Seward Peninsula.

In addition to the principal assigned work of this group of engineers, their familiarity with mining matters throughout many parts of the Territory and their availability for consultation enabled them to give much valuable information and advice to many of the Federal and Territorial agencies in Alaska as well as to many individuals, including the Alaska Railroad, the Forest Service, the governor, members of the Territorial legislature, and many operators and prospectors. The Alaska office also acts as a local distributing office for handling publications of the Geological Survey and assists in furnishing the main office with information on many phases of the mineral industry.

The Alaska office was one of the activities transferred to the Geological Survey from the Bureau of Mines when that bureau was taken over into the Department of Commerce at the beginning of the last fiscal year. One of the reasons for that change was that economies of operation might be effected. It has not yet been practicable to put into effect many of the changes that would produce closer coordination between the two types of work carried on by the Alaskan branch, because both appropriations have been materially reduced, so that the work could not be maintained even on its former scale. It is planned, however, that when funds are available fuller utilization of this office in the regular mineral-resources work of the Alaskan branch will be made and that it will participate in many of the activities now carried on under the other appropriation.

For the field season of 1927, the beginning of which is financed from 1927 funds and the later part from 1928 funds, there will be some further curtailment, as only \$14,500 has been allotted for this work from the 1928 appropriation. This amount will be barely sufficient to pay the salaries of the permanent force engaged in leasing work with a small allowance for the maintenance of the office and the necessary traveling expenses. The present plans, therefore, contemplate the continuance of only the most pressing of the investigations and will doubtless necessitate even further reduction of personnel if the essential duties are to be performed. Under these conditions no broad, systematic scheme of investigation can be planned in advance, but instead only a few of the specific jobs as they arise can be given attention.

TOPOGRAPHIC BRANCH

C. H. BIRDSEY, Chief Topographic Engineer

ORGANIZATION AND PERSONNEL

The organization of the topographic branch at the end of the year remains unchanged except that J. H. Wheat, topographic engineer in charge of section of photographic mapping, has succeeded T. P. Pendleton, who resigned.

The technical force at the end of the year comprised 1 chief topographic engineer, 3 senior topographic engineers in charge of divisions, 12 topographic engineers, 2 geodetic engineers, 2 topographic and geodetic engineers, 122 associate, assistant, and junior topographic, geodetic, or cartographic engineers, and 27 engineering field aids and draftsmen, a total of 169. The clerical force comprised 13 clerks.

EXPENDITURES

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1927

State or project	Appropriation, topographic surveys	Repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Appropriations and allotments.....	\$451,700.00	\$43,831.75	\$495,531.75	\$409,393.70	\$904,925.45
Credits on account of refunds.....	1,358.94	573.05	1,931.99		1,931.99
Total funds available.....	453,058.94	44,404.80	497,463.74	409,393.70	906,857.44
Expenditures:					
Alabama.....	16,219.51		16,219.51	13,938.21	30,157.72
Arizona.....	24,003.11	5,157.63	29,160.74	25,000.00	54,160.74
Arkansas.....	43.33		43.33		43.33
California.....	26,242.34	5,092.86	31,335.20	14,000.84	45,336.04
Colorado.....	17,951.88		17,951.88	14,714.43	32,666.31
Delaware.....	9,230.16		9,230.16	2,915.25	12,145.41
Georgia.....	561.18		561.18	1,073.60	1,634.78
Hawaii.....	24,606.39		24,606.39	19,001.86	43,608.25
Idaho.....	3,631.46	5,539.19	9,170.65		9,170.65
Illinois.....	40,938.74		40,938.74	53,049.07	93,988.41
Iowa.....	1,466.98		1,466.98	1,434.67	2,901.65
Kansas.....	5,838.93		5,838.93		5,838.93
Kentucky.....	49,323.41		49,323.41	49,998.30	99,321.71
Maine.....	5,580.87		5,580.87	7,048.46	12,629.33
Michigan.....	17,844.38		17,844.38	19,166.41	37,010.79
Missouri.....	16,241.20		16,241.20	13,500.05	29,741.25
Nevada.....	1,038.78		1,038.78		1,038.78

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1927—Continued

State or project	Appropriation, topographic surveys	Repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Expenditures—Continued.					
New Hampshire.....	\$9,804.49	\$11,845.59	\$21,650.08	\$25,089.93	\$46,740.01
New Mexico.....	130.72		130.72	3,000.00	3,130.72
New York.....	10,153.38		10,153.38	20,000.00	30,153.38
North Dakota.....	10,451.60		10,451.60	15,983.80	26,435.40
Oklahoma.....	841.28		841.28		841.28
Oregon.....	5,338.37	2,238.27	7,576.64	2,307.76	9,884.40
Pennsylvania.....	29,857.90		29,857.90	29,750.61	59,608.51
Tennessee.....	15,300.70		15,300.70	11,529.03	26,829.73
Texas.....	18,095.93		18,095.93	21,277.03	39,372.96
Utah.....	6,108.87		6,108.87	7,056.98	13,165.85
Vermont.....	1,792.04		1,792.04	5,098.62	6,890.66
Virginia.....	11,573.10		11,573.10	15,612.81	27,185.91
Washington.....	5,915.77		5,915.77	1,476.59	7,392.36
West Virginia.....	2,960.55		2,960.55		2,960.55
Wisconsin.....	16,834.01		16,834.01	16,368.80	33,202.80
Books for library.....	147.17		147.17		147.17
Computing.....	* 3,794.55		3,794.55		3,794.55
Contingent.....	6,057.24		6,057.24		6,057.24
Field distribution offices.....	1,003.33		1,003.33		1,003.33
Field instruments.....	* 2,085.35		2,085.35		2,085.35
Field stationery.....	* 150.00		150.00		150.00
Geographic names.....	3,826.36		3,826.36		3,826.36
Inspection and editing.....	* 4,139.34		4,139.34		4,139.34
Map information.....	3,199.38		3,199.38		3,199.38
One-millionth maps.....	8,275.57		8,275.57		8,275.57
Miscellaneous repay.....		14,531.26	14,531.26		14,531.26
Office salaries.....	* 5,404.44		5,404.44		5,404.44
Photographic mapping.....	* 855.29		855.29		855.29
Relief maps.....	1,413.89		1,413.89		1,413.89
Total expenditures.....	446,273.36	44,404.80	490,678.16	409,393.70	900,071.86
Budget reserve.....	5,800.00		5,800.00		5,800.00
Unexpended balance.....	985.68		985.68		985.68
	453,058.94	44,404.80	497,463.74	409,393.70	906,857.44

- * Represents 26 per cent of expenditure; balance of 74 per cent included in charges for State cooperation.
 † \$381,911.83 expended on State cooperation.

GENERAL OFFICE WORK

General office work consisted in the inking and inspection and editing of the topographic field sheets prior to their submission for reproduction and in the computation and adjustment of the results of control field work. The preparation of a new base map of the United States was completed. A map of the Tacna-Arica area was prepared for the Department of State, and a map of the town of Arica was made for the Boundary Survey Commission. Cooperation with the Air Corps, United States Army, was continued whereby aerial photographs were furnished for use in topographic mapping.

SUMMARY OF RESULTS

The status of topographic surveys on June 30, 1927, is shown in the following table:

New topographic surveys in the United States, July 1, 1926, to June 30, 1927, and total area surveyed in each State—Continued

State	Publication contour interval (feet)	Mapped in fiscal year (square miles) for publication on scale of 1 to—					Total area mapped in fiscal year (square miles)			Percent- age of total area of State mapped to June 30, 1927	River sur-veys, scale 1: 31,680 (linear miles)	Spirit levels (miles)	Transit traverse (miles)	Trian- gula- tion stations occu- pied
		12,000	24,000	31,680	48,000	62,500	125,000	250,000	Revi- sion					
South Carolina	20									44.3				
South Dakota	20									24.8				
Tennessee	2, 5, 10, 20									54.6				
Texas	20		263			659				22,950		247	105	
Utah	5, 25		179			472				86,286				
Vermont	20					324				19,035		30		
Virginia	10, 20, 50			70		685				7,264		44		
Washington	100									37,546		335		14
West Virginia	50					789				34,534				
Wisconsin	20					426				24,170				
Wyoming										17,376		134	182	
										30,102				
Total continental United States (ex- clusive of Alaska)		84	1,013	804	143	13,813	840	120	983	1,990	13,934	5,170	3,287	38
Hawaii	50					696				696	300	28		
										42.9				
										88.2				

FIELD SURVEYS

Alabama.—In cooperation with the State geologist of Alabama the survey of the Montgomery, Adger, and Entaw quadrangles was completed.

Arizona.—In cooperation with the State water commissioner of Arizona the survey of the Bridge Canyon, Stoval, and Sentinel No. 2 quadrangles and of a dam site on Williams River, in Yuma County, was completed and that of the Big Horn Mountains, Kim, Sentinel No. 3, Quartzsite No. 1, Quartzsite No. 2, Powell No. 1. and Powell No. 4 quadrangles was begun. For the conservation branch a plan and profile survey of Little Colorado River was completed.

California.—In cooperation with the State engineer of California the survey of the Angiola, Stratford, Porterville, Delano, Pixley, Earlimart, Allensworth, Ducor, Richgrove, No. 47, No. 48, and No. 54 quadrangles and of the Terra Bella project (parts of the Ducor, Porterville, Success, and No. 49 quadrangles) was completed and that of the No. 55 quadrangle was begun. At the request of the National Park Service the survey of the Lassen Volcanic National Park was completed. The survey of the Elk Hills Naval Reserve was begun.

Colorado.—In cooperation with the Colorado School of Mines the survey of the Grand Valley, Roan Creek, and Highmore quadrangles was completed and that of the Taylor Park quadrangle was begun. In cooperation with the Colorado Metal Mining Fund the survey of Bonanza and vicinity was extended. At the request of the National Park Service the culture was revised for a part of the Mesa Verde National Park.

Delaware.—In cooperation with the State Highway Department of Delaware the resurvey of the Deepwater Point quadrangle was continued and that of the Naxontown Pond quadrangle was begun (areas previously surveyed on a smaller scale).

Georgia.—In cooperation with the State geologist of Georgia the resurvey of the Tate quadrangle was completed (area previously surveyed on a smaller scale).

Hawaii.—In cooperation with the commissioner of public lands of the Territory of Hawaii the survey of the Waiki NE. $\frac{1}{4}$ and SE. $\frac{1}{4}$, Kahohe SE. $\frac{1}{4}$ and NE. $\frac{1}{4}$, Humuila SW. $\frac{1}{4}$ and NW. $\frac{1}{4}$, and Mauna Kea SE. $\frac{1}{4}$ quadrangles and the island of Niuhau was completed and that of the Humuila NE. $\frac{1}{4}$ quadrangle was begun.

Idaho.—At the request of the Forest Service the survey of the Casto quadrangle was completed. For the conservation branch a plan and profile survey of Clark Fork from Horse Creek, Mont., to Albany Falls, Idaho, and Pend Oreille Lake was completed.

Illinois.—In cooperation with the Illinois Department of Registration and Education, Geological Survey, the survey of the Normal and Mount Sterling quadrangles and the Illinois part of the Vera and Nebo quadrangles was completed and that of the Pearl, Meredosia, Glasford, Iuka, Danvers, McLean, and Le Roy quadrangles and the Illinois part of the Alton quadrangle was begun. The resurvey of the Springfield quadrangle was completed. The resurvey of the Wheeling, Highland Park, Harvey, Chicago Loop, Park Ridge, Jackson Park, Calumet City, Evanston $7\frac{1}{2}'$, Tinley Park, Englewood, and Elmhurst quadrangles was completed and that of the Calumet Lake and Mokena quadrangles was begun (areas previously surveyed on a smaller scale).

Indiana.—In cooperation with the Illinois Department of Registration and Education the resurvey of the Indiana part of the Calumet Lake and Calumet City quadrangles was completed.

Iowa.—In cooperation with the director of the Iowa Geological Survey the survey of the Bondurant quadrangle was begun.

Kentucky.—In cooperation with the State geologist of Kentucky the survey of the Taylorsville quadrangle and of the Kentucky part of the Paducah, Greenup, Big Stone Gap, Byrdstown, Lillydale, Tompkinsville, Mound City, and Smithland quadrangles was completed and that of the La Grange, Big Clifty, Creelsboro, and Chilesburg quadrangles was begun. The resurvey of the Kentucky part of the Middlesboro, Hagan, and Sneedville quadrangles was completed (areas previously surveyed on a smaller scale).

Maine.—In cooperation with the Public Utilities Commission of Maine the survey of the Dixfield quadrangle was completed and that of the Rumford Falls, Stockholm, and Bigelow quadrangles was begun. In cooperation with the War Department the survey of the Lake Duncan quadrangle was begun.

Michigan.—In cooperation with the Michigan Department of Conservation, Geological Survey, the survey of the Mount Clemens, Corunna, Three Oaks, South Haven, and Glen Lord quadrangles was completed and that of the Benton Harbor, Niles, and Breedsville quadrangles was begun.

Missouri.—In cooperation with the State geologist of Missouri the survey of the Des Arc quadrangle was completed and that of the Knob Lick and Twelve-mile quadrangles and the resurvey of the Fulton No. 2 quadrangle was begun.

Nevada.—At the request of the geologic branch the survey of the Lowry Peak quadrangle was completed. At the request of the Navy Department a reconnaissance survey of Dry Valley, in the vicinity of Sand Pass, Washoe County, was completed.

New Hampshire.—In cooperation with the Highway Department of New Hampshire the survey of the Mount Kearsarge, Hillsboro, and Lovewell Mountain quadrangles and the New Hampshire part of the Claremont quadrangle was completed and that of the Danbury and Mascoma Lake quadrangles was begun. In cooperation with the War Department the survey of the New Hampshire part of the Averill quadrangle was completed and that of the Second Lake quadrangle was begun.

New Mexico.—In cooperation with the State engineer of New Mexico the survey of the Tucumcari quadrangle was begun.

New York.—In cooperation with the New York State engineer the resurvey of the Cohoes and Cossack quadrangles was completed and that of the Schenectady quadrangle was resumed. In cooperation with the commissioners of the Palisades Interstate Park the survey of the Palisades Park was begun.

North Dakota.—In cooperation with the State engineer of North Dakota the survey of the Kongsburg, Coleharbor, Benedict, Minot, Dogden, and Sawyer quadrangles was completed and that of the Drake quadrangle was begun.

Oregon.—In cooperation with the State engineer of Oregon the survey of the Bend quadrangle was completed. At the request of the Forest Service the survey of the Elkhorn quadrangle was completed. For the conservation branch plan and profile surveys of the Middle Fork of Willamette River and Sandy River were completed.

Pennsylvania.—In cooperation with the Pennsylvania Department of Forests and Waters, Topographic and Geological Survey, the survey of the Youngsville quadrangle was completed; that of the Eagles Mere, Titusville, Townville, and Tidioute quadrangles was continued; and that of the Clearville and Hyndman quadrangles was begun.

Tennessee.—In cooperation with the Tennessee State geologist the survey of the Gordonsville and Decherd quadrangles was completed and that of the Erin quadrangle was begun.

Texas.—In cooperation with the Texas Board of Water Engineers the survey of the Quanah 3-a and Quanah 3-b quadrangles was completed. In cooperation with the State Reclamation Department of Texas the survey of the Upper Brazos River project, Marlin to Jones Bridge, was completed. In cooperation with Orange County, Tex., the survey of the Orange County part of the Lakeview, Mauriceville, Texla, Terry, Orangefield, Vidor, Echo, and Orange quadrangles was completed. In cooperation with separate interests acting through the Texas Board of Water Engineers the survey of the Lufkin 4-b, Lufkin 4-c, Lufkin 4-d, Zavalla 3-c, Zavalla 3-d, Colmesneil 2-b, and Livingston 1-a quadrangles of the Neches River project was begun.

Utah.—In cooperation with Weber and Davis Counties, Utah, and the Bureau of Reclamation the survey of these counties was continued.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Vermont part of the Claremont and Walpole quadrangles was completed and that of the Hyde Park quadrangle was begun. In cooperation with the War Department the survey of the Vermont part of the Averill quadrangle was completed.

Virginia.—In cooperation with the director of the Geological Survey of Virginia the survey of the Critz quadrangle was completed. The resurvey of the Covesville quadrangle was completed and that of the Remington and Speedwell quadrangles was begun (areas previously surveyed on a smaller scale).

Washington.—In cooperation with the Department of Conservation and Development of Washington the survey of the Chewelah quadrangle was resumed. At the request of the Forest Service the survey of the Washington part of the Hood River quadrangle was completed.

West Virginia.—In cooperation with the State geologist of West Virginia the culture was revised for the Logan and Holden quadrangles and for the West Virginia part of the Matewan and Naugatuck quadrangles.

Wisconsin.—In cooperation with the Geological and Natural History Survey of Wisconsin the survey of the Whitehall, North Bend, and Galesville quadrangles and the Wisconsin part of the Winona quadrangle was completed, that of the Strum quadrangle resumed, that of the Montana quadrangle continued, and that of the La Crescent quadrangle begun.

WATER-RESOURCES BRANCH

N. C. GROVER, Chief Hydraulic Engineer

ORGANIZATION AND PERSONNEL

The organization of the water-resources branch is the same as last year, and the changes in personnel show a net increase of 3 in the technical force. At the end of the year the force comprises 118 technical and 25 clerical employees.

FUNDS

The funds available for disbursement by the Geological Survey for the work on water resources were as follows:

Gaging streams	\$151,000.00
Repayments by cooperating Government or State organizations	132,565.31
	<hr/> 283,565.31

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Arizona	\$17,000.00
California:	
State	\$23,513.07
County and city (gaging streams)	18,644.87
Municipal (ground water)	3,422.76
	<hr/> 45,580.70
Colorado	806.02
Hawaii:	
Territory	\$26,827.92
Municipal	1,080.07
	<hr/> 27,907.99
Idaho:	
Gaging streams	13,861.32
Ground water	250.00
	<hr/> 14,111.32
Illinois:	
State	4,791.70
Municipal	60.00
	<hr/> 4,851.70
Iowa	1,492.81
Kansas:	
State	\$1,666.53
Municipal	60.00
	<hr/> 1,726.53
Maine	5,215.27

Maryland:		
State.....	\$296. 46	
Municipal.....	136. 12	
		\$432. 58
Massachusetts.....		3, 801. 44
Minnesota.....		378. 53
Missouri.....		9, 881. 92
Montana.....		4, 943. 43
Nevada.....		1, 687. 11
New Hampshire.....		1, 895. 31
New Jersey:		
Stream gaging.....	\$11, 249. 35	
Ground water.....	7, 878. 19	
		18, 127. 54
New Mexico:		
State.....	347. 16	
County.....	2, 615. 78	
		2, 962. 94
New York:		
State.....	17, 595. 88	
Municipal.....	84. 00	
		17, 679. 88
North Carolina:		
State.....	6, 793. 08	
Municipal.....	727. 83	
		7, 520. 91
Ohio.....		25, 315. 65
Oregon:		
State.....	\$4, 901. 24	
Municipal.....	1, 413. 93	
		6, 405. 17
Pennsylvania.....		1, 684. 00
Tennessee.....		13, 724. 46
Texas.....		25, 035. 96
Utah.....		6, 495. 49
Virginia.....		14, 099. 03
Washington:		
State.....	\$6, 751. 82	
Municipal.....	1, 372. 58	
		8, 124. 40
West Virginia.....		399. 86
Wisconsin.....		6, 844. 93
Wyoming.....		4, 826. 01
		301, 458. 89

The work done under cooperative agreements with the States has been restricted to studies of stream flow, except in Idaho, New Jersey, New Mexico, and Pennsylvania, where ground-water investigations have been made. (See pp. 48, 49.)

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects under construction was continued in cooperation with the Bureau of Reclamation. The field work was done by Geological Survey engineers, and the cost was met by the Bureau of Reclamation through transfer of funds. Geological investigations were made for the Bureau of Reclamation in New Mexico and Washington.

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued in the Colville, Western Shoshone, and Walker River Reservations and on the Gila and San Carlos Rivers.

National Park Service.—Streams in the Yosemite and Yellowstone National Parks were measured during the year at stations maintained in cooperation with the National Park Service.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service.

Weather Bureau.—Stream gaging has been continued on Colorado River in Arizona in cooperation with the Weather Bureau.

Office of the Chief of Engineers.—Stream gaging has been done in the basins of Tennessee and Cumberland Rivers in cooperation with the office of the Chief of Engineers.

Bureau of Mines.—An examination for a ground-water supply near Amarillo, Tex., was made for the Bureau of Mines.

Department of Justice.—A study of the ground-water supply for a Federal institution near Alderson, W. Va., was made for the Department of Justice.

Department of State.—Within the year the Geological Survey has taken over from the Department of State the stream gaging related to the division between the United States and Canada of the waters of Milk and St. Mary Rivers and between the United States and Mexico of the waters of the Rio Grande. An investigation is being made for the Department of State of seepage losses in the Rio Grande with especial view to the possible location of reservoir sites. The cost of all this work is met by funds transferred to the Geological Survey from the Department of State.

Federal Power Commission.—The operations of 1 licensee of the Federal Power Commission in Arizona, 14 in California, 1 in Colorado, 7 in Idaho, 1 in Montana, 2 in Nevada, 9 in Oregon, 1 in Utah, 6 in Washington, and 1 in Wisconsin and of 3 permittees of the commission in Arizona, 1 in Colorado, 4 in Idaho, 2 in Oregon, 1 in Wyoming-Utah, and 1 in Wyoming were supervised by the Geological Survey. All stream gaging by permittees of the commission is done in cooperation with the Geological Survey. Such co-operative stream gaging is in progress in Alabama, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Maine, Michigan, Minnesota, Missouri, Montana, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 17 reports and 4 separate chapters. At the end of the year 8 other reports were in press and 27 manuscripts were awaiting editorial work or funds for publication.

CHARACTER AND METHOD OF WORK

The study of surface waters, which consists primarily of the measurement of the flow of streams, has been conducted in 41 States and Hawaii at selected gaging stations at which the volume of water carried by the streams is measured and records of stage and other data, from which the daily flow of the stream is com-

puted, are collected. At the end of the year 1,749 gaging stations were being maintained; 234 stations were discontinued and 253 new stations established during the year. Records for about 130 additional stations were received, ready for publication, from Government bureaus and private persons, and a number of Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

The demands of the public for precise information in regard to ground-water resources are becoming more and more exacting with increasing need for the water. In recent years considerable research into the principles of ground-water hydrology has been undertaken in order to provide a more secure basis for ground-water investigations. Work on the laws of head and flow of artesian water has been done in the investigations of four great artesian basins—that of the Dakota sandstone in North and South Dakota, that of the Coastal Plain of New Jersey, the Roswell Basin in New Mexico, and the basin in the vicinity of Honolulu. Critical studies of the principles of recharge and discharge of ground water, fluctuations of the water table, and the relation of vegetation to ground water have been made especially in the investigations in the Escalante Valley, Utah, and the Mokelumne area in California. In connection with these studies a hydrologic laboratory and three experiment stations have been maintained, about 30 automatic water-stage recorders have been installed over observation wells, and thousands of measurements of water levels in wells have been made. One of the products of this work is a paper by O. E. Meinzer on the compressibility and elasticity of artesian aquifers. During the year considerable attention was given by Mr. Meinzer to the geology of large springs, the occurrence and behavior of ebbing and flowing springs, the history of the development of quantitative methods in ground-water work in this country and in Europe, the data and laws of seepage losses from streams, and the general problem of making inventories of the water that falls as rain or snow.

In recent years most of the geologic investigations of reservoir sites have been made by the division of ground water, and much attention has been given to the principles involved and to the available methods of investigation. A brief general paper on the geology of reservoir and dam sites, with a bibliography, has been prepared by Kirk Bryan for publication as a water-supply paper. During the year investigations relating to ground water and reservoir sites were conducted in 16 States and Hawaii. About 40 investigations were in progress, of which 18 were completed and reports thereon submitted. Of the completed reports 12 related to ground water and 6 to reservoir sites. Eight reports that were completed in this or previous years were published, 3 of them by the Geological Survey and 5 by the State of New Mexico. Cooperation was continued with the North Dakota and Minnesota well drillers' associations, especially with the committees of these associations on specifications for class A farm wells. Attention was also given to projects for organizing associations in several other States with a view to developing higher standards and better results in water-well drilling. The division was instrumental in bringing about a conference in the National Research Council on well drilling and well records, which resulted in the organization of a committee on conservation of scientific results of

rilling and improvement of drilling methods and equipment, which functions as a committee of the National Research Council and also as the national committee of the International Well Drilling Congress. Mr. Meinzer serves as the representative of water-well drilling in this committee and also as the representative of hydrology on the council's committee on sedimentation. A systematic effort is made to maintain contact with European hydrologists, and abstracts of papers published in this country on ground-water hydrology are furnished to the *Revue de géologie* and the *Zentralblatt*.

The work on quality of water involved the examination of 534 samples of water with reference to their dissolved mineral matter and of 218 samples taken in connection with the study of silt carried by streams. Information as to the chemical character of surface and ground water is collected and is made available through publication and by correspondence. The methods used for the analysis of water are described in a manuscript that was nearly completed for publication during the year 1927. A short paper on "Natural sodium bicarbonate waters in the United States," by W. D. Collins and C. S. Howard, was published in *Industrial and Engineering Chemistry*, and a note on "The radioactivity of natural waters," by W. D. Collins, was published in *Public Health Reports*.

The work of the division of power resources comprised the preparation of monthly and annual reports of the production of electricity and consumption of fuel by public-utility power plants, a report of the developed water power of the United States, and compilations of the stocks of coal held by electric public-utility power plants for inclusion in reports of commercial stocks of coal undertaken quarterly by the Bureau of Mines of the Department of Commerce. The monthly and annual figures of output of electricity and fuel consumption are based on reports submitted by concerns producing electricity for public use. On January 1, 1927, 2,058 companies operating 3,805 power plants with a total capacity of generators of 25,398,000 kilowatts were on the list of companies requested to submit reports of the operation of their power plants. Plants whose output is less than 10,000 kilowatt-hours a month are not included. Reports are received from plants representing over 95 per cent of the capacity of all plants listed. The output of plants not reporting is estimated.

Electricity produced at public-utility power plants in the United States, 1919-1926

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)
1919	38,921,000,000		14,606,000,000	37.5		24,315,000,000	62.5	
1920	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921	40,975,000,000	-5.9	14,970,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922	47,654,000,000	+16.3	17,207,000,000	36.1	+14.9	30,447,000,000	63.9	+17.1
1923	55,665,000,000	+16.8	19,343,000,000	34.8	+12.4	36,322,000,000	65.2	+19.3
1924	59,013,000,000	+6.0	19,969,000,000	33.8	+3.2	39,044,000,000	66.2	+7.5
1925	65,870,000,000	+11.6	22,356,000,000	33.9	+11.9	43,514,000,000	66.1	+11.4
1926	73,791,000,000	+12.0	26,189,000,000	35.5	+17.1	47,602,000,000	64.5	+9.4

Fuel consumed in the production of electricity at public-utility power plants in the United States, 1919-1926

Year	Coal		Fuel oil		Gas	
	Short tons	Change from previous year (per cent)	Barrels	Change from previous year (per cent)	M cubic feet	Change from previous year (per cent)
1919.....	35,100,000		11,050,000		21,406,000	
1920.....	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921.....	31,685,000	-14.9	12,045,000	-8.2	23,722,000	-4.0
1922.....	24,179,000	+8.2	13,197,000	+9.6	27,172,000	+14.5
1923.....	38,966,000	+14.0	14,654,000	+11.3	31,483,000	+15.9
1924.....	37,558,000	-3.6	16,630,000	+13.3	48,443,000	+32.9
1925.....	40,222,000	+7.1	10,246,000	-38.4	46,521,000	-4.6
1926.....	41,811,000	+2.7	9,399,000	-8.3	53,207,000	+14.4

The marked improvement in the utilization of fuel by electric public-utility power plants during the period covered by these power reports was continued during 1926, when the average consumption of coal was 1.95 pounds per kilowatt-hour, a decrease of about 7 per cent from the figure for 1925. The conservation of fuel due to this increase in efficiency in the seven years since 1919 amounted to about 100,000,000 tons of coal. Tables showing the capacity of all prime movers used in the production of power in the United States and the amount of power produced by electric public-utility power plants were compiled and prepared for publication in Water Supply Paper 579, which will contain the following separate papers: "The development of horsepower equipment in the United States," by C. R. Daugherty; "Developed and potential water power in the United States and monthly production of electricity by public-utility power plants, 1919-1926," by A. H. Horton; and "Growth of water-power development in the United States," by R. W. Davenport.

The investigation of the water power and irrigation resources of the public lands has been continued during the year in areas designated and with the use of funds provided by the conservation branch. The work has been done by a small personnel working from three field offices. It has consisted of the examination of streams, including the location and survey of power and reservoir sites, and of neighboring lands to determine their value for power or irrigation, and the preparation of reports, either for office use or for publication, on the power value of streams.

WORK OF THE YEAR BY STATES

The following table shows by States the number of gaging stations maintained for the collection of stream-flow records and the interest in those stations of the agencies cooperating with the Geological Survey:

g stations maintained by the Geological Survey and cooperating parties for the year ended June 30, 1927

State or Territory	Geological Survey alone	Bureau of Reclamation	Forest Service	Indian Office	Army engineers	Weather Bureau	Other Federal bureaus	State cooperation	Municipal cooperation	Private persons	Counted more than once	Maintained at end of year	Established during year	Discontinued during year	Regular gaugings during year	Miscellaneous gaugings during year
Alabama		1		3	6	3		1		9	1	15	5		57	7
Alaska								42	4	2	15	40	2	1	995	12
Arizona			20	1			5	223	64	97	185	1	13	14	6	414
Arkansas		2						32	3	7	11	33	2	1	142	3
California										2					7	
Colorado										6		6	4		52	26
Connecticut										10		10	3		70	59
Delaware		6	6			2		106	132	80	91	241	123	125	2,169	367
District of Columbia					2	2		34	1	5	10	34	4	1	58	1
Florida								1		1		1			3	
Georgia					6			11		6	2	21			83	5
Idaho					3			24	1	3	7	24			92	1
Illinois					12					13	12	13		1	48	17
Indiana								19		9	9	19	2		125	1
Iowa	2							2	4	2	2	8	2		83	5
Kansas								17		1	1	17		1	108	8
Kentucky										2		2			3	
Louisiana					2			5		7		14		2	21	
Maine																
Maryland					1	2		56		20	23	56	4	5	337	10
Massachusetts		2	2				23	40		7		74	10	2	281	10
Michigan				2				18		8	10	18	1	2	48	1
Minnesota								16		13	13	16	1		60	6
Mississippi						1		36	8	5	14	36	1	1	264	57
Missouri															1	
Montana					1			76	1	42	44	76	6	4	559	5
Nebraska					16			41	11	13	37	44	2	15	179	21
Nevada					5	3		92	15	6	29	92	9		375	30
New Hampshire										2		2			14	
New Jersey						8		88	23	51	83	88	12	15	576	54
New Mexico								2		2	2	2	2			
New York										7		7	3		46	8
North Carolina																
North Dakota					58	6		61		10	74	61	6		378	10
Ohio					12	5		101	15	14	46	101	14	14	790	58
Oklahoma		4				1		54	1	16	22	54	5	5	162	31
Oregon										5		5			8	
Pennsylvania						1		57	3	11	15	57	10	1	257	8
Rhode Island	1		2	4	1		2	48	23	30	48	62	10	6	321	164
South Carolina					7			1		8		17		5	20	
South Dakota					1			36		9	10	36	2	6	142	10
Tennessee		6		4		1	7	21		6	6	39	4	1	137	2
Texas								80	6	22	28	80	5	3	292	140
Utah																
Vermont																
Virginia																
Washington																
West Virginia																
Wisconsin																
Wyoming																
Total	3	21	31	14	112	50	43	1,441	315	570	851	1,749	253	234	12,765	1,551

Alaska.—Five samples of spring water were analyzed for the Alaska Rail-

Arizona.—Some progress was made on a report on the geology and water resources of San Pedro Valley, by Kirk Bryan and G. E. P. Smith. Water-y Paper 596-B, "Quality of water of Colorado River, 1925-26," was red and analyses were made of additional samples collected from the throughout the year at Grand Canyon, Topock, and Yuma. Field studies

S. Howard at the sampling points improved the methods of sampling made the results more useful. Hydraulic engineers accompanied a topo-ic survey party that mapped Little Colorado River from Tolchico to the of the river. Surveys of all dam sites in that stretch were made their supervision, and a report on the potential water power and storage ities of the dam sites is in preparation.

Arkansas.—Studies of the temperature and mineral composition of the water t Springs National Park were continued by Mr. Bryan.

California.—Water levels were measured in selected wells in southern California under the direction of F. C. Ebert. The record now covers a period of 23 years. Work was actively continued on an investigation of the ground water in the alluvial fan of Mokelumne River by H. T. Stearns, T. W. Robinson, B. S. Barnes, and G. H. Taylor. This investigation receives financial support from the East Bay municipal utility district. The work has been extended, at the request of the State division of water rights, to include the adjacent fan of Calaveras River. Some of the large and hot springs in the region of volcanic rock in northeastern California were examined by Messrs. Meinzer and Stearns, and Mr. Stearns prepared a brief paper on the geology of the Lava Beds National Monument. The geology of the Mill Creek and Elk Creek dam sites and Round Valley reservoir site, on the Middle Fork of Eel River, in Mendocino County, was examined by Mr. Stearns, who prepared a report on the subject. Field and office studies were made of the probable future stages of Salton Sink, and a report is being prepared for office use in determining whether the amount of land withdrawn from settlement along the shore shall be increased or decreased.

Colorado.—Reports have been completed on the water-power resources of the upper San Juan River and on the utilization of Colorado River in Colorado and Utah to the mouth of Green River.

District of Columbia.—Analyses were made of 16 samples of boiler water and scale in connection with studies of the Bureau of Mines on the operation of Government boiler plants in the District.

Florida.—Eight additional analyses were made for the report on the chemical character of the waters of Florida, which had been transmitted for publication in September, 1925.

Hawaii.—The report on methods of exploring and repairing leaky artesian wells on the island of Oahu by John McCombs was published as a part of Water Supply Paper 596-A. The report on "Geology and ground-water resources of the Kau district, Island of Hawaii," by H. T. Stearns and W. O. Clark, with an introductory chapter on the ground-water conditions in the Hawaiian Islands by O. E. Meinzer, was completed and is to be published as a water-supply paper.

Idaho.—Observations were continued in the Mud Lake Basin, and some progress was made by Mr. Stearns and L. L. Bryan on the final report on this basin. The geology and water supplies of the Craters of the Moon National Monument were studied in cooperation with the Idaho Bureau of Mines and Geology by Mr. Stearns, who prepared a report concerning an improved water supply for the monument, which was transmitted to the National Park Service, and a report on the volcanic features of the monument, which was transmitted to the Idaho Bureau of Mines and Geology for publication. A manuscript report on the power resources of the Clearwater River Basin was completed and opened for public inspection.

Louisiana.—Six waters associated with oil and gas wells in and near Ouachita Parish were analyzed.

Montana.—Progress on the reports on the ground-water resources of Big Horn and Fergus Counties was made by G. M. Hall. An office study was made of the water supply of streams in the Clark Fork Basin.

New Jersey.—The investigation of the quantities of ground water available in different parts of New Jersey was continued during the year in cooperation with the State Department of Conservation and Development. The work was in charge of D. G. Thompson, who was assisted in the first part of the year by E. W. Downs and later by H. C. Barksdale. A report on the Asbury Park area was completed and transmitted to the Department of Conservation and Development for publication, and progress was made on a report on the Camden area. Observations were continued, as in previous years, at two experiment stations and on numerous observation wells. New work was begun on water in the Triassic rocks in the Metropolitan district. Analyses of 54 samples of water were made, and 36 were tested with reference to contamination with salt water.

New Mexico.—Five reports prepared by the division of ground water were published in the Seventh Biennial Report of the New Mexico State Engineer, as follows: "Report on investigations in the Roswell Artesian Basin," by A. G. Fiedler; "Geology and artesian water prospects in the San Jose-Rio Puerto Valley, in Sandoval County," by B. C. Renick; "Ground-water reconnaissance in Socorro County," by Kirk Bryan; "Ground-water reconnaissance in DeBaca County," by Kirk Bryan; and "Geology and ground-water resources of the drainage basin of the Rio Penasco above Hope," by B. C. Renick. The investigation of the Roswell artesian basin was continued by Mr. Fiedler and S.

Spencer Nye, with financial support from the State and from Chaves and Eddy Counties. The geology of the country along Gallinas River with reference to possible seepage losses was examined by A. M. Piper for the Bureau of Reclamation, in connection with the adjudication of water rights on the Pecos River system. The geology of two reservoir sites along the Rio Pecos was studied by Mr. Nye, and a report thereon was transmitted to the State engineer. The geology of the vicinity of the Avalon Reservoir, in the Carlsbad project, was investigated by Kirk Bryan with reference to possible leakage if the reservoir were enlarged, and a report was transmitted to the Bureau of Reclamation.

North Carolina.—A paper on "Surface waters of North Carolina," by Margaret D. Foster, was published in *Industrial and Engineering Chemistry*. The 18 new analyses in this paper and 41 others were transmitted to the State Department of Conservation and Development for publication with other analyses to be made by the State.

Oregon.—A report on reservoir and tunnel sites in the Owyhee irrigation project, by Mr. Bryan, was completed for publication in a water-supply paper. Geologic examinations of 43 dam sites in the western part of the State were made by Mr. Stearns, who prepared a report on these sites. Mr. Stearns also partly completed a report on the geology and water resources of the middle Deschutes Basin.

Pennsylvania.—A report on the ground water in 14 counties in southeastern Pennsylvania, including Philadelphia, was nearly completed by Mr. Hall. A survey of the ground-water conditions in six counties in the southwestern part of the State, including Pittsburgh, was made by Mr. Piper, and a report on this area was partly prepared by him. Analyses were made of 98 samples of water collected by Mr. Piper. The ground-water work in Pennsylvania is conducted in cooperation with the State geologist.

Rhode Island.—A report on the chemical character of the waters of Rhode Island, for which analyses were made in 1928, was practically completed.

South Carolina.—Some progress was made on a report on the geology and ground-water conditions of the Coastal Plain of South Carolina, by C. W. Cooke, of the geologic branch.

South Dakota.—A paper entitled "Problems of the soft-water supply of the Dakota sandstone, with special reference to the conditions at Canton, S. Dak.," was prepared by Mr. Meinzer for publication as a contribution to hydrology.

Tennessee.—Plans were perfected for a survey of ground water in Tennessee, to be undertaken, in cooperation with the State Geological Survey, in the fiscal year 1928.

Texas.—Several days were spent by Mr. Meinzer, in company with J. A. Norris, chairman of the State Board of Water Engineers, and C. E. Ellsworth, district engineer, in a study of the decline in head in the artesian basin in the vicinity of Glen Rose. An examination in the vicinity of Amarillo was made by Mr. Nye to assist the Bureau of Mines in locating a water supply for a helium-processing plant. The chemical character of nine samples of water was determined by partial analyses.

Utah.—The study of discharge of ground water in Escalante Valley, Utah, was continued by W. N. White, and he prepared a preliminary report on the subject. Considerable progress has been made on a report on the utilization of Green River in Wyoming, Colorado, and Utah. Data on the power value of lands along Ogden and Provo Rivers and in Tooele County were prepared for office use. A supplementary report, based on a field investigation made in a previous year on an application for right of way for a canal on Huntington River, was made at the request of the Federal Power Commission. In connection with the supervision of investigational work and construction under permits and licenses of the Federal Power Commission a report was made to the commission on the application of the Utah Power & Light Co. for a license to develop power at the Flaming Gorge site on Green River.

Virginia.—At the request of the State geologist, an examination of the ground-water conditions in the vicinity of Pulaski was made by Mr. Meinzer, who prepared a report on the sources for an enlarged water supply for that city. This report was transmitted by the State geologist to the city authorities. Observations were made by Mr. Meinzer on two of the ebbing and flowing springs in the State. A project was begun to make weekly measurements of the water level in a well in Arlington County in order to have reliable information as to the stage of the water table.

Washington.—A brief report on the geology of the proposed pressure tunnel in the Kittitas division of the Yakima project was prepared by Mr. Bryan and

transmitted to the Bureau of Reclamation. Analyses of six samples and partial analyses of three samples of surface waters were made for the city of Tacoma in connection with studies of additional water supply. Work has been continued on river surveys and power investigations of streams draining the Olympic Range.

West Virginia.—An examination of the ground-water conditions at the Federal prison near Alderson was made by Mr. Meinzer, and a report by him, with recommendations for drilling, was transmitted to the Department of Justice.

CONSERVATION BRANCH

HERMAN STABLER, Chief

The field work of the conservation branch is coextensive with the public domain of the United States, including Alaska, and with the principal mineral-producing Indian reservations. Its duties include the classification of lands according to their highest use, the protection of the public interest in undeveloped mineral, water power, and agricultural resources, and the promotion of economical and efficient development of mineral deposits on public and Indian land.

PERSONNEL CHANGES

During the fiscal year there were 30 separations, all resignations except four terminations by reason of discontinuance of work, and 34 appointments were made. On June 30, 1927, the personnel of the branch, both office and field, numbered 141, consisting of 79 professional and subprofessional and 62 clerical employees. The turnover of professional field employees was reduced from 50 to 33 per cent during the year.

FUNDS

The funds appropriated for the work of the conservation branch for the fiscal year were as follows:

Classification of lands.....	\$240, 000
Supervision of leasing operations.....	292, 500
Supervision of naval-reserve operations.....	50, 000
	<hr/>
	582, 500

This is a decrease of more than \$38,000 from the appropriations for the preceding year.

CORRESPONDENCE

During the year 24,170 letters were received in the Washington office, a decrease of 436 from the fiscal year 1926. In addition, about 27,500 pieces of miscellaneous correspondence were received for information, transmitted to the appropriate field office, or filing. Within the same period 18,652 letters and reports were prepared and sent out, a decrease of 1,135. In addition, about 10,850 pieces of miscellaneous correspondence were sent out. There was, however, a material increase in pending material or unfinished business.

SUMMARY OF OPERATIONS BY STATES

Alaska.—Work limited mostly to handling in the Washington office of applications under public-land laws and maintaining records of and furnishing advice for mineral-leasing operations, which include 1,039 oil and gas prospecting permits, 9 coal leases, 20 coal permits, and 3 coal licenses; coal production, 93,416 tons. Increased power-site reserves by 4,531 acres.

Alabama.—Supervised coal lease of 1,840 acres, production 22,845 tons; made reconnaissance of oil and gas operations.

Arizona.—Made field investigation of homestead applications; designated 9,680 acres under the enlarged and 41,407 acres under the stock-raising homestead act; reserved 15,286 acres as power sites and eliminated 9,006 acres from power-site reserves; increased public-water withdrawals by 2,295 acres; made survey and began report on water power and irrigation of basin of Little Colorado River; supervised operations on 3 coal permits, 810 oil and gas permits, 3 sodium permits, and 22 potash permits, and on Indian lands.

Arkansas.—Increased power-site reserves by 1,120 acres; supervised 4 oil and gas permits.

California.—Made field examinations of homestead applications; designated 21,764 acres under the enlarged and 75,990 acres under the stock-raising homestead act; increased public-water withdrawals by 8,731 acres; added 144,596 acres to power-site reserves and eliminated 1,754 acres; examined and reported on power sites in Eel River Basin and requirements of drainage reservoir for Salton Sea Basin; examined structural conditions with respect to oil and gas in parts of Ventura and Kern Counties; supervised 5 coal permits, 5 potash leases with production of 5,911 tons of salts, 1 sodium permit, and 2,755 oil and gas permits and 140 leases with production of 19,759,637 barrels and royalty of \$4,415,740.80; maintained office and oil-field camp at Taft.

Colorado.—Made field examination of homestead applications and general agricultural classification of plains area; designated 36,041 acres under the enlarged and 155,565 acres under the stock-raising homestead act; increased public-water withdrawals by 80 acres; reserved 24,175 acres as power sites; made power surveys, investigations, or reports on Colorado, Green, and San Juan Rivers; eliminated 60,741 acres from coal-land withdrawal and classified 19,080 acres as coal land; defined the "known geologic structure" of the North McCallum oil and gas field; made coal investigations in Routt, Mesa, and Moffat Counties; made oil and gas investigations in Baca and parts of adjacent counties; supervised 34 coal permits, 8 licenses, and 60 leases with production of 448,552 tons, 3 potash permits, and 3,078 oil and gas permits and 8 leases with production of 723,193 barrels and royalty of \$55,456.24; maintained offices at Denver.

Florida.—Eliminated 6,330 acres from phosphate withdrawal; investigated phosphate lands in Charlotte, Glades, Highlands, and Lee Counties.

Idaho.—Made field examination of homestead applications; designated 20,095 acres under the enlarged and 81,953 acres under the stock-raising homestead act; increased public-water withdrawals by 160 acres; added 122,738 acres to power-site reserves and eliminated 5,221 acres; made investigations and surveys of power possibilities on Middle and South Forks of Salmon River, Boise River and tributaries, and Clark Fork, including Pend Oreille Lake; eliminated 5,080 acres from phosphate withdrawal; made miscellaneous mineral examinations; supervised 7 coal permits, 1 sodium permit, 2 phosphate leases with production of 23,854 tons, and 168 oil and gas permits.

Kansas.—Made field examination of homestead applications and general agricultural classification of western part; designated 320 acres under the enlarged-homestead act; supervised 5 oil and gas permits.

Louisiana.—Made reconnaissance of oil and gas operations; supervised 45 oil and gas and sulphur permits with production of 26,371 barrels and royalty of \$12,013.32.

Michigan.—Supervised 1 oil and gas permit.

Mississippi.—Made reconnaissance of oil and gas operations, classified 42 acres as oil and gas land, supervised 2 oil and gas permits.

Montana.—Made field examination of homestead applications and general agricultural classification of plains region; designated 42,244 acres under the enlarged and 133,444 acres under the stock-raising homestead act; eliminated 40 acres from public-water reserves; added 177 acres to power-site reserves and eliminated 2,000 acres; eliminated 277,109 acres from coal withdrawal and classified 142,028 acres as coal land; revised definition of "known geologic structure" of Cat Creek oil and gas field; made coal investigations in Carbon, McCone, and Powder River Counties; supervised 12 coal permits, 7 licenses, and 45 leases with production of 278,896 tons, 3,077 oil and gas permits and 40 leases with production of 1,226,274 barrels and royalty of \$139,474.88, and operations on Indian lands; maintained offices at Billings, Shelby, and Cat Creek.

Nebraska.—Made field examination of homestead applications and general agricultural classification of western part; designated 5,235 acres under the stock-raising homestead act; supervised 9 oil and gas permits.

Nevada.—Made field examination of homestead applications; designated 1,845 acres under the enlarged and 45,901 acres under the stock-raising home-

stead act; designated 17,040 acres under the ground-water reclamation act, added 1,110 acres to public-water reserves; added 398 acres to power-site reserves; supervised 3 coal permits, 15 sodium permits, 1 sodium lease with production of 302 tons of salts, 2 potash permits, and 836 oil and gas permits.

New Mexico.—Made field examination of homestead applications; designated 105,356 acres under the stock-raising homestead act; added 925 acres to public-water reserves; eliminated 2,797 acres from power-site reserves; made survey and examination of power and irrigation possibilities of San Juan Basin; eliminated 73,713 acres from coal withdrawal and classified 12,288 acres as coal land; examined oil and gas regions and prepared structural map of Artesia oil field; supervised 60 coal permits and 9 leases with production of 85,905 tons, 1 sodium permit, 24 potash permits, and 3,616 oil and gas permits and 8 leases with production of 39,804 barrels and royalty of \$9,445.74; maintained offices at Shiprock and Roswell; supervised oil and gas operations on Navajo Indian Reservation.

North Dakota.—Made field examination of homestead applications and general agricultural classification of western part; designated 955 acres under the enlarged-homestead act; supervised 3 coal permits, 2 licenses, and 32 leases with production of 215,540 tons, and 25 oil and gas permits.

Oklahoma.—Made field examination of homestead applications; designated 2,057 acres under the stock-raising homestead act; made coal examination in the vicinity of Stigler; revised definition of "known geologic structure" of Red River oil fields; prepared structural map of Red River oil fields; supervised lead, zinc, coal, oil, and gas leasing operations on Indian lands, and made aero-photographic map of Quapaw lead and zinc lands; supervised 58 oil and gas permits and 17 leases on public lands with production of 491,254 barrels and royalty of \$182,829.59; maintained offices at Muskogee, Cushing, Okmulgee, Shawnee, Sapulpa, McAlester, Miami, and Ardmore.

Oregon.—Made field examination of homestead applications; designated 3,233 acres under the enlarged and 58,352 acres under the stock-raising homestead act; added 320 acres to public-water reserves; added 98,746 acres to power-site reserves, and eliminated 1,931 acres; made power surveys, investigations, and reports on Middle Fork of Willamette, Sandy, Umpqua, McKenzie, and Siletz Rivers; supervised 4 coal permits and 2 coal leases with production of 423 tons, 1 sodium permit, 1 potash permit, 1 oil-shale lease, and 59 oil and gas permits.

South Dakota.—Made field examination of homestead applications and general agricultural examination of western part; designated 11,105 acres under the stock-raising homestead act; added 40 acres to power-site reserves; supervised 1 coal lease with production of 912 tons and 137 oil and gas permits.

Utah.—Made field examination of homestead applications; designated 116,360 acres and eliminated 239,160 acres from designation under the enlarged-homestead act; designated 164,103 acres and eliminated 5,640 acres from designation under the stock-raising homestead act; eliminated 560 acres from public-water reserves; added 10,455 acres to power-site reserves and eliminated 2,964 acres; continued preparation of report on power resources of Colorado and Green Rivers; eliminated 106,225 acres from coal withdrawal and classified 18,383 acres as coal land; eliminated 529,363 acres from oil withdrawal; made coal investigations in Grand and Sanpete Counties, asphalt investigations near Vernal, and oil and gas investigations in Grand, Wayne, and San Juan Counties; supervised 24 coal permits, 3 licenses, and 43 leases with production of 282,564 tons, 1 sodium permit, 40 potash permits, and 4,379 oil and gas permits and 2 leases with royalty of \$1,070.52; maintained offices at Salt Lake City.

Washington.—Made field examination of homestead applications; designated 5,250 acres under the enlarged and 7,540 acres under the stock-raising homestead act; added 100,145 acres to power-site reserves and eliminated 1,025 acres; made surveys, investigations, and reports on power possibilities of rivers of Olympic Peninsula; supervised 8 coal permits and 1 coal lease with production of 30,974 tons, 2 sodium permits, and 72 oil and gas permits.

Wisconsin.—Added 643 acres to power-site reserves.

Wyoming.—Made field examination of homestead applications and general agricultural classification of plains region; designated 46,431 acres under the enlarged and 149,896 acres under the stock-raising homestead act; eliminated 600 acres from public-water withdrawals; added 62 acres to power-site reserves and eliminated 1,938 acres; began report on power resources of Green River; eliminated 86,435 acres from coal withdrawal and reduced area classified as coal land by 2,301 acres; defined "known geologic structure" of Elk Basin

and Wertz dome oil and gas fields; prepared structural maps of Big Sand Draw and Powder River Station-Country Club district, Natrona County; made coal investigations in Park County, asphalt investigations near Baggs, and phosphate investigations in Sublette County; remapped Teapot dome, Natrona County; supervised 12 coal permits, 5 licenses, and 33 leases with production of 1,053,037 tons, 4,929 oil and gas permits and 272 leases with production of 16,463,982 barrels and royalty of \$4,753,317.31, and operations on Indian lands; maintained offices at Casper, Midwest, and Thermopolis.

SUMMARY OF LAND-CLASSIFICATION CASES

The activities of the conservation branch with respect to land classification include the preparation of reports in response to requests for data or action on specific cases, the preparation of orders of withdrawal and restoration of lands not involved in specific requests, and the promulgation of broad areal classifications. The following table summarizes activity with respect to requests for data or action on specific cases, and the terms "gain" and "loss" signify, respectively, decrease and increase in the number of cases pending. It is regretted that in spite of strenuous effort and the voluntary overtime work of an efficient personnel it proved impossible to keep the work on cases current during the year. During the preceding year the case work of the branch dropped behind about half a month. In the fiscal year 1927, though more cases were acted on, nearly 10 per cent more were up for action, and the work dropped behind about one month additional. As the work is delayed it is inevitably increased by the necessity of answering additional inquiries as to status of cases.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1926-27						Record since receipt of first case	
	Pending July 1, 1926	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1927	Gain or loss during fiscal year	Received	Acted on
General Land Office requests:								
General.....	226	1,632	1,858	1,378	480	-254		
Time extensions.....	46	667	713	666	47	-1	1,001	954
Oil development.....	261	1,428	1,689	1,104	585	-324	3,245	2,660
Applications for classification as to mineral:								
Coal.....	0	3	3	2	1	-1	6	5
Oil.....	5	6	11	6	5		773	768
Oil.....	288	709	997	841	156	+132	6,163	6,007
Phosphate.....	0	0	0	0	0		35	35
Applications for mineral permits:	422	5,631	6,053	5,050	1,003	-581	44,035	43,032
Applications for mineral leases:	23	122	145	127	18	+5	1,116	1,098
Applications for patent, potassium:	0	0	0	0	0		123	123
Federal Power Commission cases:								
Preliminary permits.....	6	3	9	3	6		59	53
Licenses.....	11	0	11	1	10	+1	22	12
Determinations under section 24.....	11	30	41	36	5	+6	158	163
Applications for reclassification as to water resources:	6	21	27	20	7	-1	678	671
Applications for rights of way:	37	124	161	128	33	+4	5,920	5,887
Irrigation project reports:	0	6	6	1	5	-5	898	893
Applications under enlarged-homestead acts:	146	328	474	231	243	-97	56,067	55,824
Applications under stock-raising homestead act:	1,272	3,000	4,272	3,101	1,171	+101	118,345	117,374
Applications under ground-water reclamation act:	20	34	54	27	27	-7	863	836
Indian Office requests for information:	2	3	5	5	0	+2	9,505	9,505
Cases in national forests:	2	7	9	8	1	+1	312	311
	2,784	13,754	16,538	12,735	3,803	-1,019		

MINERAL-CLASSIFICATION DIVISION

The work of the mineral-classification division involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, chiefly through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation. The results of its work take the form of mineral classifications, of orders of withdrawal, modification, and restoration, and of reports concerning the mineral character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public-land and Indian-land laws.

Because of small personnel and the volume and pressure of demands in connection with the handling of cases, particularly those involving the administration of the mineral-leasing laws, the branch made little headway during the year in classifying the vast areas throughout the West that are still embraced in mineral withdrawals. The results accomplished include, however, net decreases of 604,223 acres in the total area of outstanding coal withdrawals, of 529,363 acres in the total area of outstanding petroleum withdrawals, and of 11,410 acres in the total area of outstanding phosphate reserve.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications June 30, 1927, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash (with- drawn)
	With- drawn	Classi- fied as coal land	With- drawn	Classi- fied as oil land	With- drawn	Classi- fied as oil-shale land	With- drawn	Classi- fied as phos- phate land	
Alaska		56,993							
Arizona	139,415		92,496						
Arkansas		61,100							
California	17,603	8,720	1,178,392						90,518
Colorado	4,180,736	3,193,502	218,997		64,500	952,239			
Florida							78,192	120	
Idaho	4,761	4,603					391,532	268,290	
Louisiana			466,990	4,233					
Montana	7,883,164	8,500,671	1,350,426	67,651			279,944	3,833	
Nevada	83,673				123				30,422
New Mexico	5,084,069	570,372							7,418,437
North Dakota	5,954,364	11,178,280	84,894						
Oregon	4,361	18,887							
South Dakota		250,093							
Utah	3,636,541	1,270,972	1,311,264		91,464	2,703,755	301,945	100	
Washington	691,801	141,444							
Wyoming	2,260,604	6,738,516	545,737			460,103	992,969	25,298	
	29,941,092	32,054,219	5,279,196	71,884	156,147	4,116,097	2,044,582	297,705	7,648,377

Since February, 1920, the principal activity of the mineral-classification division has been connected with the administration of the mineral-leasing laws. Every application for a prospecting permit or lease under any of these laws is carefully scrutinized, and a report is made to the Commissioner of the General Land Office or the Secretary of the Interior on the geologic conditions involved. Applications for coal permits require a determination of the necessity for prospecting any or all of the land sought. Applications for coal leases entail a division of the area sought into logical operating or leasing units consistent in area and content of coal with the scale of mining operations proposed and the recommendation of appropriate requirements as to royalty, minimum investment, and minimum annual production. Applications for oil and gas prospecting permits require a determination of the structural relations of the land sought with respect to those of other permit and lease holdings of the applicant elsewhere in the same State and with respect to the "known geologic structure" of any producing oil or gas field and, if in conflict with an unperfected entry under the nonmineral-land laws, classification as to the prospective oil and gas value of the entered land. Applications for oil and gas leases involve a determination of the validity and sufficiency of the oil or gas discovery alleged and a recommendation of appropriate royalty requirements. Applications for sodium permits or leases, potassium permits, leases, or patents, and oil-shale leases entail generally similar determinations and recommendations.

The following table summarizes the results of the year's work to the extent that they involve specific applications for permit or lease rights under the leasing laws. No applications for patent rights were received during the year.

Applications received, acted on, and pending under the mineral-leasing acts, fiscal year 1926-27

Mineral	Permits			Leases		
	Received	Acted on	Pending	Received	Acted on	Pending
Oil and gas.....	5, 242	4, 671	968	27	32	2
Coal.....	209	194	31	86	91	10
Phosphate.....				6		
Sodium.....	20	22		1	2	
Potassium.....	159	162	4	1	1	
Oil shale.....				1	1	
Sulphur.....	1	1				

In addition to the work summarized the division determines and defines the limits of the "known geologic structure" of producing oil and gas fields and reports on the structural relations of lands involved in proposed assignments of leases or permits, on the status and structural significance of drilling on or adjacent to lands involved in permit relinquishments or cancellations, on the feasibility of permit and lease consolidations, on the propriety of time extensions based

on alleged contributions to drilling on lands other than those described in the permit of the contributor, and on the beneficial or adverse effects on present or future mineral development of all applications for rights of way across withdrawn, classified, or defined public lands. The net area included in outstanding definitions of the "known geologic structure" of producing oil and gas fields on June 30, 1927, was 512,843 acres in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Other phases of division activity include the scrutiny of all enlarged and stock-raising homestead designations for the elimination of any lands within the limits of defined or producing oil or gas "structures," the examination of all right-of-way applications for the prevention of interference with operations on lands valuable for coal or other minerals, and the preparation of reports at the request of the General Land Office and Office of Indian Affairs on the mineral possibilities of lands sought under certain nonmineral-land laws.

Geologic field work undertaken by this division to provide the basis for appropriate action on pending petitions for mineral classification or reclassification and on applications for mineral permits and leases included areal and structural mapping and detailed economic studies of small areas in many parts of the public-land States. Numerous areas in New Mexico, Colorado, Wyoming, and Idaho were examined, and structure contour maps were prepared for the Artesia oil field, New Mexico; the Big Sand Draw gas field, Wyoming; and the Powder River Station-Country Club district, Natrona County, Wyo. The occurrence of coal in the Silvertip anticline, Park County, Wyo., and Carbon County, Mont., was mapped in detail, the occurrence of rock phosphate in the Tump Range, Sublette County, Wyo., was investigated, and a structural reconnaissance of Baca County, Colo., and parts of contiguous counties was made. Structural conditions in parts of Ventura and Kern Counties, Calif., were investigated, and a reconnaissance of oil and gas operations in Alabama, Mississippi, and parts of Louisiana was made. The remapping of the Teapot dome, Natrona County, Wyo., was begun. The occurrence of bone phosphate in parts of Charlotte, Glades, Highlands, and Lee Counties, Fla., was investigated.

The large items of field work undertaken by the geologic branch but financed largely by the conservation branch during the year included areal and structural examinations in Grand, Wayne, and San Juan Counties, Utah; coal investigations in the vicinity of Stigler, Okla., in Routt, Mesa, and Moffat Counties, Colo., in Grand and Sanpete Counties, Utah, and in McCone and Powder River Counties, Mont.; and asphalt investigations near Baggs, Wyo., and Vernal, Utah.

POWER DIVISION

The work of the power division consists primarily in obtaining and making available for use in the administration of the public-land laws information as to the water-power resources of the public

lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public-land laws. An endeavor is made to determine the proper administrative action by which the possibility of power development may be preserved with minimum interference with agricultural, transportation, or other interests. In the course of this work a review of all power reserves is carried on in order that all land having primary value for the development of power, and only such land, shall be reserved for that purpose. The extent of this task is indicated by the fact that areas aggregating more than 6,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches of the Geological Survey. The larger field projects undertaken during the year to obtain information for power classification include plan and profile surveys and power-site and reservoir-site investigations on Quinault and Wynooche Rivers, Washington; Middle Fork of Willamette and Sandy Rivers, Oreg.; Middle and South Forks of Salmon River, Boise River, and Clark Fork, including Pend Oreille Lake, Idaho; and Little Colorado River, Ariz. Studies were continued leading to the preparation of reports on Green and Colorado Rivers in Colorado, Utah, and Wyoming; San Juan River and tributaries in Colorado and New Mexico; Eel River and Salton Sea basin in California; and Umpqua, McKenzie, and Siletz Rivers in Oregon. Geologic examinations were made at over 40 reservoir and dam sites. Because of decrease in appropriation projects previously undertaken in Idaho, Arizona, and California were dropped toward the end of the year and a number of projects planned were not begun.

The information obtained is indexed and incorporated in an inventory of water resources which, when complete, will enable the Geological Survey to give competent advice on short notice as to the manner in which each tract of public land having value for power can best be used in connection with the development of water power and as to the relation of such use to other possible uses of the tract. Copies of many of the reports on the power possibilities of the streams examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press.

The work of the division is briefly summarized in the accompanying tables showing power-site reserves and outstanding water resources, withdrawals, and classifications and in the general summary of cases involving land classification (p. 53).

Pursuant to instructions of the Secretary of the Interior dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted by the Secretary

since January 1, 1913, were called upon for detailed reports of the operation or development of their power systems during the calendar year 1926. The total installation of the reporting companies is 1,970,000 kilowatts, of which 1,430,000 kilowatts is installed at hydraulic plants. The total energy generated was 7,800,000,000 kilowatt-hours, of which more than 6,500,000,000 kilowatt-hours was generated by water power.

Power output of permittees and grantees, 1916-1926

Year	Kilowatt-hours	Increase or decrease		Year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1916.....	1,200,000,000			1922.....	4,947,000,000	+1,222,000,000	+33
1917.....	2,000,000,000	+800,000,000	+67	1923.....	5,910,000,000	+963,000,000	+19
1918.....	3,200,000,000	+1,200,000,000	+60	1924.....	6,100,000,000	+164,000,000	+3
1919.....	3,100,000,000	-100,000,000	-3	1925.....	6,930,000,000	+830,000,000	+14
1920.....	4,300,000,000	+1,100,000,000	+35	1926.....	7,800,000,000	+870,000,000	+13
1921.....	3,725,000,000	-475,000,000	-11				

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications and other types of reserves are included in the total areas without distinction.]

State	Reserved prior to July 1, 1926	Eliminated prior to July 1, 1926	Reserves outstanding prior to July 1, 1926	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1927
Alabama.....	2,377		2,377			2,377
Alaska.....	213,646	520	213,126	4,531		217,657
Arizona.....	1,270,395	114,344	1,156,051	5,286	9,666	1,151,671
Arkansas.....	28,551		28,551	1,120		29,671
California.....	1,170,617	28,489	1,142,128	144,596	1,754	1,284,970
Colorado.....	507,096	75,783	431,315	24,175		455,490
Florida.....	486		486	533		1,019
Idaho.....	467,807	186,300	281,507	122,738	5,221	399,024
Michigan.....	1,240		1,240			1,240
Minnesota.....	19,062	532	18,530			18,530
Mississippi.....	3		3			3
Montana.....	303,589	94,379	209,210	177	2,000	207,387
Nebraska.....	761		761			761
Nevada.....	300,796	480	300,316	398		300,716
New Mexico.....	270,878	7,714	263,164		2,797	260,367
Oregon.....	654,437	110,317	544,120	98,746	1,931	640,935
South Dakota.....	12		12	40		52
Utah.....	746,254	122,434	623,820	10,455	2,964	630,311
Washington.....	292,617	52,810	239,807	100,142	1,028	339,934
Wisconsin.....	1,210	226	984	643		1,627
Wyoming.....	222,560	73,408	149,152	62	1,938	147,276
	6,474,398	868,736	5,605,662	513,642	29,296	6,099,008

*Summary of outstanding water resources, withdrawals, and classifications
June 30, 1927, in acres*

State	Power reserves					Reser- voir with- drawals	Public- water with- drawals	Ground- water reclama- tion designa- tions
	With- drawals	Classi- fications	Designa- tions *	Miscel- laneous	Total			
Alabama.....	120	1,735	.....	522	2,377	.....	.....	.....
Alaska.....	93,415	43,005	.....	81,237	217,657	.....	.....	.....
Arizona.....	386,259	37,182	528,239	199,991	1,151,671	23,040	17,575	.....
Arkansas.....	22,354	1,590	.....	5,727	29,671	.....	.....	.....
California.....	287,391	292,974	.....	704,605	1,284,970	1,160	171,282	.....
Colorado.....	231,910	174,661	.....	48,919	455,490	1,728	2,300	.....
Florida.....	.....	.....	.....	1,019	1,019	.....	.....	.....
Idaho.....	205,637	184,049	.....	9,338	399,024	.....	18,345	.....
Michigan.....	1,240	.....	.....	1,240	.....	.....	.....	.....
Minnesota.....	12,309	.....	.....	6,221	18,530	.....	.....	.....
Mississippi.....	.....	.....	.....	3	3	.....	.....	.....
Montana.....	129,944	53,452	.....	23,991	207,387	9,080	8,057	.....
Nebraska.....	761	.....	.....	761	.....	.....	.....	.....
Nevada.....	27,492	28,026	.....	245,198	300,716	.....	9,256	1,576,295
New Mexico.....	117,206	.....	143,161	.....	260,367	.....	9,881	.....
North Dakota.....	.....	.....	.....	.....	.....	1,569	.....	.....
Oregon.....	372,738	192,292	15,250	60,655	640,935	10,619	20,501	.....
South Dakota.....	.....	.....	.....	52	52	.....	240	.....
Utah.....	442,375	162,826	.....	25,110	630,311	80	32,915	.....
Washington.....	97,086	180,691	.....	61,147	338,924	35,943	920	.....
Wisconsin.....	.....	.....	.....	1,627	1,627	.....	.....	.....
Wyoming.....	80,891	25,621	.....	40,764	147,276	1,714	79,305	.....
	2,509,128	1,378,104	686,650	1,516,126	6,090,008	84,933	365,577	1,576,295

* Designated and not otherwise withdrawn.

AGRICULTURAL DIVISION

The functions of the agricultural division, formerly called the homestead division, consist of the classification of lands under the enlarged-homestead law as nonirrigable; the classification of lands under the Nevada ground-water reclamation law as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public-land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; and the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family.

Applications for classification are disposed of in accordance with the results of field examinations by members of the division and with information obtained from other sources. Applications in some regions lead to the planning and execution of broad field studies that result in the classification of large areas and provide in advance the basis for appropriate action on new applications.

The number of cases received and acted on during the fiscal year by the agricultural division is shown in the general summary of

cases (p. 53). There was a slight increase in the number received, but the work of the division was kept substantially current. In the field broad areal studies were made in the central Great Plains region in Colorado, Kansas, Nebraska, and Wyoming. Detailed examination of lands embraced in specific applications for designation under the enlarged and stock-raising homestead laws was continued in all the public-land States west of the one hundredth meridian. A report, begun in 1925 in cooperation with the Department of Agriculture, on agriculture and land utilization in the northern Great Plains region, was practically completed during the year, and a preliminary edition of a map in eight sheets showing the agricultural classification of lands in this region was produced.

During the year the area designated under the Nevada ground-water reclamation act, as a result of the work of the division, was increased from 1,559,255 to 1,576,295 acres. Outstanding withdrawals, aggregating 11,530 acres, under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

Summary of enlarged-homestead designations, in acres

[Areas classified as arid and nonirrigable, residence by entrymen required (act of February 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 132), applicable to California, North Dakota; act of March 3, 1915 (38 Stat. 953), applicable to Kansas; act of March 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (act of February 19, 1909 (35 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho)]

State	Designations prior to July 1, 1926	Cancellations prior to July 1, 1926	Designations outstanding prior to July 1, 1926	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1927
Arizona.....	31,421,499	5,870,874	25,550,625	9,680	-----	25,560,305
California.....	13,255,780	238,453	13,017,327	21,764	-----	13,039,091
Colorado.....	33,682,752	195,508	33,487,244	36,041	-----	33,523,285
Idaho:						
Total.....	13,670,724	460,925	13,209,799	20,095	-----	13,229,894
Nonresidence.....	572,747	4,233	568,514	-----	-----	568,514
Kansas.....	650,084	-----	650,084	320	-----	650,404
Montana.....	53,415,606	245,728	53,169,878	42,244	-----	53,212,122
Nevada.....	50,106,320	3,580,717	46,525,603	1,845	-----	46,527,448
New Mexico.....	43,772,180	227,732	43,544,448	-----	-----	43,544,448
North Dakota.....	12,276,749	3,848	12,272,901	856	-----	12,273,756
Oregon.....	21,273,454	989,902	20,283,552	3,253	-----	20,286,805
South Dakota.....	16,336,096	348,170	15,987,926	-----	-----	15,987,926
Utah:						
Total.....	11,535,304	460,924	11,074,470	116,360	239,160	10,951,670
Nonresidence.....	1,645,969	78,600	1,567,369	1,920	2,960	1,566,329
Washington.....	6,649,942	251,842	6,398,100	5,250	-----	6,403,350
Wyoming.....	29,547,901	182,043	29,365,858	46,431	-----	29,412,289
	337,654,481	13,036,666	324,617,815	304,238	230,160	324,682,893

* Includes 920 acres previously designated under secs. 1-5, now designated under sec. 6.

Summary of stock-raising homestead designations, in acres

sified as nonirrigible, nontimbered, chiefly valuable for grazing and raising forage crops, and of character that 640 acres is reasonably required for the support of a family (act of December 29, Stat. 862)]

State	Designations prior to July 1, 1926	Cancellations prior to July 1, 1926	Designations outstanding prior to July 1, 1926	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1927
-----	13, 947, 007	887, 580	13, 059, 517	41, 407	-----	13, 100, 924
-----	1, 120	-----	1, 120	-----	-----	1, 120
-----	7, 812, 309	1, 400	7, 810, 909	75, 990	-----	7, 886, 899
-----	8, 355, 436	18, 840	8, 337, 096	153, 565	-----	8, 492, 661
-----	480	480	-----	-----	-----	-----
-----	5, 367, 664	1, 854	5, 365, 810	81, 953	-----	5, 447, 763
-----	114, 139	-----	114, 139	-----	-----	114, 139
-----	3, 451	-----	3, 451	-----	-----	3, 451
-----	15, 206, 290	17, 081	15, 189, 209	133, 444	-----	15, 322, 653
-----	189, 574	-----	189, 574	5, 235	-----	194, 809
-----	520, 133	3, 120	517, 013	45, 961	-----	562, 974
-----	31, 179, 252	636	31, 178, 616	106, 356	-----	31, 283, 972
-----	375, 892	-----	375, 892	-----	-----	375, 892
-----	80, 025	-----	80, 025	2, 067	-----	82, 092
-----	6, 252, 407	3, 128	6, 249, 279	58, 352	-----	6, 307, 631
-----	6, 485, 433	550	6, 484, 883	11, 105	-----	6, 496, 988
-----	1, 487, 667	880	1, 486, 787	164, 103	5, 640	1, 645, 250
-----	682, 621	1, 134	681, 487	7, 540	-----	689, 027
-----	19, 939, 752	6, 213	19, 933, 539	149, 896	-----	20, 083, 435
-----	118, 001, 242	942, 896	117, 058, 346	1, 047, 964	5, 640	118, 100, 670

blanket order of withdrawal creating Public Water Reserve No. 17, which received Executive approval April 17, 1926, every smallest legal subdivision of the public-land surveys which is vacant unappropriated public land and contains a spring or water hole and is located within a quarter of a mile of every spring or water hole located on unsurveyed public land was reserved for public use and subject to pending legislation. This order obviated the necessity for the withdrawal of specific tracts valuable for stock watering requires a determination by the division with respect to all entries on public land whether or not any of the subdivisions involved are affected by it. On the basis of such determination orders of withdrawal are issued from time to time listing by legal subdivision of the public-land survey any tracts found to contain a water hole affected by the order. During the year the known area included in public-water reserves, mainly for stock watering, was designated as follows:

	Acres		Acres
-----	2, 335	New Mexico-----	1, 085
-----	120	Oregon-----	320
-----	80	Utah-----	80
-----	160	Wyoming-----	160
-----	1, 110		

The eliminations from such reserves were as follows:

	Acres		Acres
Arizona-----	40	Utah-----	640
New Mexico-----	160	Wyoming-----	840
Montana-----	40		

Outstanding withdrawals of public land for public watering places are tabulated in the summary of water-resources withdrawals and classifications (p. 59).

MINERAL-LEASING DIVISION

The work of the mineral-leasing division is supervisory (both inspectional and regulatory) with respect to operations for the discovery and development of petroleum, natural gas, oil shale, coal, phosphate, sodium, potassium, and sulphur on public lands, of petroleum and natural gas on naval petroleum reserves, and of a variety of minerals on Indian lands. This work is carried on with a minimum of administrative supervision from Washington through district offices and suboffices at or near the primary centers of mining or drilling activity, under the direction of responsible engineers who have full authority to represent the Government within their jurisdiction and to enforce compliance with the law and regulations under which operations are conducted.

ACTIVITIES ON THE PUBLIC DOMAIN

The supervisory work of the mineral-leasing division on public lands subject to the mineral-leasing laws, in so far as it can be measured by the number of cases, was increased about 20 per cent during the year by the receipt of issued prospecting permits, leases, and licenses as follows: Oil and gas permits 4,591, 8,292,516.09 acres; oil and gas leases 53, 23,781.97 acres; coal permits 88, 98,148.58 acres; coal leases 25, 8,780.32 acres; coal licenses 16, 649.95 acres; sodium permits 11, 26,229.11 acres; potash permits 59, 138,819.29 acres; total leases 78, permits 4,749, licenses 16, covering 8,588,925.31 acres. No sodium, phosphate, oil-shale, sulphur, or potash leases were issued. Although no sulphur permits or leases have been issued under the act of April 17, 1926, the 45 oil and gas permits covering 7,299.85 acres in Louisiana are given a right under the sulphur-leasing act to acquire a lease should sulphur be discovered in prospecting for oil or gas.

The following tables show, by States and by minerals, the total number of prospecting permits, leases, and licenses involving public land issued and the number under supervision at the end of the fiscal year, together with important data relative thereto:

*leases, licenses, and permits issued by the Secretary of the Interior and
otification received by the Geological Survey up to June 30, 1927*

State	Coal			Potash		Sodium		Oil shale (leases)	Phos- phate (leases)	Oil and gas	
	Leases	Per- mits	Li- censes	Leases	Per- mits	Leases	Per- mits			Leases	Per- mits
Ala.	11	35	73								1,133
Ariz.	1	6			26		3				923
Cal.		1									4
Col.	67	16		17	70		6			158	3,246
Conn.		196	18		4					10	3,331
Del.		21			1		1		2		219
Fla.										7	5
Idaho											56
Ill.											1
Ind.	56	97	10		2					40	11
Iowa					4						3,441
Kent.		42			75	1	42				13
La.	11	131			34		4			6	963
Me.	35	11	3				5				4,042
Mich.											30
Minn.											65
Mo.										18	11
Mont.	2	35			2		1	1			60
Neb.	1	5									167
Nev.	55	113	4		345		1			2	4,711
N.H.	2	52					2				81
N.J.	40	175	19	1			1	1		274	5,356
N.Y.											
Or.											
Penn.											
R.I.											
S.D.											
Tenn.											
Texas											
Verm.											
Wash.											
W. Va.											
Wis.											
Wy.											
Total	281	936	128	18	563	1	66	2	2	515	27,869

9 leases, 29,434 permits, 128 licenses. Required investment, \$10,297,370. Total area, 2,454,292.73
minimum annual production of coal required, 4,168,740 tons. Estimated quantity of coal in leased
00,000 tons.

*leases, licenses, and permits on the public domain under supervision of
the Geological Survey June 30, 1927*

State	Coal						Oil and gas	
	Leases		Permits		Licenses		Leases (num- ber)	Permits (number)
	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres		
Ala.	9	11,307.28	20	29,912.21	3	30.00		1,039
Ariz.	1	1,840.00						
Cal.			3	7,600.00				810
Col.			5	2,916.16			140	4
Conn.	60	9,416.43	34	18,846.28	8	320.06	8	2,755
Del.			7	8,557.96				3,078
Fla.								168
Idaho							6	5
Ill.								45
Ind.								1
Iowa								2
Kent.	45	6,590.96	12	3,956.06	7	279.95	40	3,077
La.								9
Me.			3	6,001.21				836
Mich.	9	3,761.10	60	96,942.08			6	3,616
Minn.	32	4,264.75	3	800.00	2	80.00		25
Mont.								47
Neb.							17	11
Nev.	2	2,095.24	4	1,840.00				59
N.H.	1	79.04						137
N.J.	43	35,523.07	24	26,324.10	3	160.00	2	4,379
N.Y.	1	600.00	8	4,594.30				72
Or.	33	14,997.55	12	11,329.48	5	199.95	272	4,929
Penn.								
R.I.								
S.D.								
Tenn.								
Texas								
Verm.								
Wash.								
W. Va.								
Wis.								
Wy.								
Total	236	90,475.42	195	218,619.84	28	1,069.98	491	25,104

Mineral leases, licenses, and permits on the public domain under supervision of the Geological Survey June 30, 1927—Continued

State	Sodium				Potash			
	Leases		Permits		Leases		Permits	
	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres
Arizona.....			3	7,360.00			22	55,040.00
California.....			1	2,560.00	5	9,783.80		
Colorado.....							3	7,040.00
Idaho.....			1	2,454.11				
Nevada.....	1	1,440.00	15	35,360.00			2	3,520.00
New Mexico.....			1	2,560.00			24	54,080.00
Oregon.....			1	920.00			1	2,560.00
Utah.....			1	2,560.00			40	85,764.28
Washington.....			2	766.30				
	1	1,440.00	25	54,540.41	5	9,783.80	92	208,004.28

Also Idaho, 2 phosphate leases, 1,700 acres; Oregon, 1 oil-shale lease, 2,680 acres. Total, 736 leases, 26 licenses, 25,416 permits.

The repeal of the potash act of October 2, 1917, and what amounts to the extension of the general mineral-leasing law to include potassium minerals was a much needed piece of legislation. Under the act of 1917 a potash permittee had the right upon making discovery of potash to patent one-fourth the land contained in his permit. Prior to June 30, 1927, 563 permits, covering 1,266,005.64 acres, were issued under this act. Of this number 123 patent applications, covering about 75,000 acres, have been received for consideration by the Geological Survey. Although potash may be produced eventually from lands patented under the act, the discoveries for the most part involved inexpensive prospecting and have little present commercial interest. Potash that appears to have present commercial importance was discovered on a permit near Carlsbad, N. Mex. As a result of this discovery many additional permits have been granted, and active prospecting by core drilling is being carried out in that vicinity. The deposits discovered compare favorably in probable quantity and quality with the deposits of France and Germany, the present source of much of the American supply. The location is unfavorable for the distribution of cheap fertilizer to the farming communities of the eastern markets on account of the distance and prevailing freight rates.

PRODUCTION

Statistics relating to the production of petroleum, natural gas, natural-gas gasoline, coal, potash, phosphate, and sodium under Government lease, permit, and license involving public land are summarized in the following tables:

Petroleum produced from public lands

Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value			
			Oil	Gas	Gasoline	Total
-----	5,790,903.46	1,026,985.19	\$1,089,908.08	\$28,678.83	\$6,903.91	\$1,969,636.98
-----	14,382,826.34	2,508,994.02	2,320,801.86	86,909.24	12,864.46	3,420,665.56
-----	26,443,367.80	5,466,171.00	8,071,051.30	131,885.01	89,834.26	8,292,770.57
-----	39,437,658.44	7,672,072.04	12,082,294.00	285,565.13	70,355.28	12,192,204.51
-----	30,310,308.05	4,961,024.27	7,872,233.03	77,515.69	102,149.09	7,752,968.91
-----	29,712,876.16	4,431,608.09	7,581,065.52	59,508.29	154,265.43	8,195,439.34
-----	25,648,101.43	3,602,124.84	5,741,486.97	91,796.84	172,172.59	6,006,455.10
-----	172,694,981.00	29,877,906.09	46,691,646.96	563,846.13	578,635.72	47,794,129.81

Petroleum produced from public lands, by States

State	Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value			
				Oil	Gas	Gasoline	Total
Alaska	1920-21	2,201,116.28	311,579.19	\$573,266.63	None.	\$4,332.06	\$577,598.69
	1921-22	3,739,448.30	610,491.09	792,444.87	None.	2,985.56	795,431.43
	1922-23	4,666,823.03	674,890.86	619,391.36	\$308.31	7,673.96	637,374.63
	1923-24	4,702,633.56	630,170.36	561,064.90	897.28	3,457.29	565,419.40
	1924-25	6,978,882.39	874,515.54	1,033,142.91	1,337.43	9,723.77	1,044,204.01
	1925-26	6,467,196.06	916,301.77	983,952.57	1,581.13	18,878.41	1,004,412.11
	1926-27	7,034,271.78	961,357.05	932,806.17	3,008.48	24,195.53	980,016.18
		35,790,061.36	4,965,306.86	5,496,069.41	7,133.53	71,247.51	5,574,450.45
Alaska	1921-22	36.00	7.20	10.08	None.	None.	10.08
	1922-23	272.67	54.52	57.47	None.	None.	57.47
	1923-24	17,730.08	3,391.14	2,973.47	None.	None.	2,973.47
	1924-25	409,067.34	32,748.60	36,750.75	None.	None.	36,750.75
	1925-26	825,180.92	44,601.98	64,287.99	6.60	None.	64,294.59
	1926-27	723,198.08	40,344.11	55,294.24	162.00	None.	55,456.24
		1,975,470.04	121,147.55	159,374.00	168.60	-----	159,542.60
		35,417.54	1,678.49	12,928.49	689.92	283.22	13,901.68
Alaska	1920-21	169,634.63	9,385.64	15,406.07	None.	None.	15,406.07
	1921-22	1,535,775.75	70,443.66	185,157.86	None.	None.	185,157.86
	1922-23	2,067,446.98	183,011.71	293,978.83	None.	None.	293,978.83
	1923-24	1,496,303.77	91,885.19	202,765.36	3.20	None.	202,768.56
	1924-25	1,510,356.21	83,393.60	160,294.86	None.	None.	160,294.86
	1925-26	2,332,851.97	148,370.25	332,421.63	295.15	None.	332,716.78
	1926-27	1,226,273.71	68,819.82	139,350.75	124.13	None.	139,474.88
		10,338,642.97	625,309.87	1,329,375.36	422.48	-----	1,329,797.84
Mexico	1925-26	15,902.56	2,211.70	3,609.13	66.75	None.	3,675.88
	1926-27	39,804.17	6,189.31	8,739.83	678.00	27.91	9,445.74
		55,706.75	8,411.01	12,348.96	744.75	27.91	13,121.62
Homa	1925-26	112,160.75	17,351.41	44,353.24	None.	1,460.04	45,813.28
	1926-27	491,254.69	87,899.17	179,882.86	None.	2,946.73	182,829.59
		603,415.44	105,250.58	224,236.10	-----	4,406.77	228,642.87
-----	1925-26	2,496.41	499.29	499.29	None.	None.	499.29
	1926-27	None.	None.	None.	1,070.62	None.	1,070.52
		2,496.41	499.29	499.29	1,070.62	-----	1,569.81

Petroleum produced from public lands, by States—Continued

State	Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value			
				Oil	Gas	Gasoline	Total
Wyoming.....	1920-21	3,416,336.57	704,808.34	\$1,350,707.36	\$23,678.33	\$1,661.85	\$1,376,047.54
	1921-22	9,076,595.83	1,881,929.73	2,343,147.36	86,909.24	9,877.90	2,439,934.50
	1922-23	21,709,115.17	4,638,204.91	7,187,633.64	121,575.70	52,160.30	7,331,269.64
	1923-24	33,221,001.04	7,156,628.35	11,266,490.27	87,654.65	66,898.16	11,421,043.08
	1924-25	21,409,741.51	3,990,063.71	6,342,632.24	76,178.26	92,360.91	6,511,171.41
	1925-26	19,954,997.95	3,801,966.03	6,521,983.32	91,558.66	133,845.21	6,747,387.19
	1926-27	16,106,932.99	2,406,684.97	4,414,225.16	86,063.49	145,803.98	4,646,154.63
		124,893,721.06	24,050,303.04	39,396,814.35	573,618.33	502,670.31	40,473,102.99
Grand total.....		173,694,931.60	29,877,905.69	46,631,645.96	583,848.13	578,635.72	47,794,123.81

Coal produced from public lands, in tons

State	1920-21	1921-22	1922-23	1923-24
Alaska.....	* 65,000.00	86,551.79	116,105.99	88,645.82
Colorado.....	540.90	52,613.27	219,627.24	287,294.46
Montana.....	100.00	2,046.44	9,575.05	22,317.19
New Mexico.....		8,255.18	19,664.88	28,150.14
North Dakota.....	378.00	33,507.50	123,711.79	168,642.90
Oregon.....				51.20
South Dakota.....			586.75	427.30
Utah.....		26,185.08	103,678.44	218,439.96
Washington.....		25,565.05	60,284.64	52,757.66
Wyoming.....	229,091.70	314,016.10	445,775.49	645,379.44
	292,110.60	548,713.41	1,098,997.77	1,482,108.27

State	1924-25	1925-26	1926-27	Total
Alaska.....	99,193.83	98,144.74	93,416.14	647,058.21
Alabama.....		10,056.00	22,845.00	32,910.00
Colorado.....	297,795.51	353,433.61	448,552.09	1,639,837.08
California.....			3.00	3.00
Montana.....	218,924.90	198,602.15	278,896.48	730,472.21
New Mexico.....	18,367.56	37,461.86	85,905.31	197,794.43
North Dakota.....	127,455.19	163,533.79	215,540.12	532,789.29
Oregon.....	637.77	628.88	423.58	1,741.43
South Dakota.....	828.38	1,074.00	912.35	3,828.96
Utah.....	139,029.14	172,433.36	282,564.80	942,301.73
Washington.....	25,673.08	16,910.29	30,974.32	212,165.94
Wyoming.....	857,836.30	962,490.51	1,063,037.36	4,504,626.99
	1,785,751.66	2,014,769.19	2,512,079.55	9,735,589.45

* Estimated.

Salts disposed of from potash leases (California), in tons

1920-21.....	112.18	1925-26.....	430.00
1921-22.....	569.01	1926-27.....	5,911.35
1922-23.....	1,036.10		
1923-24.....	926.51		9,486.74
1924-25.....	501.50		

Phosphate disposed of from public lands (Idaho), in tons

1920-21.....	1,566.90	1925-26.....	343.20
1921-22.....	1,982.18	1926-27.....	23,854.61
1922-23.....	2,085.86		
1923-24.....	497.50		30,330.25

Sodium disposed of from public lands (Nevada), in tons

5 -----	248. 21	1926-27 -----	302. 58
6 -----	233. 53		784. 27

ACTIVITIES ON NAVAL PETROLEUM RESERVES

On behalf of the Bureau of Engineering, Department of the Navy, the mineral-leasing division supervises oil and gas operations in the petroleum reserves Nos. 1 and 2, in California, and No. 3, in Wyoming. On March 17, 1927, by Executive order, the administration of all naval petroleum reserves was vested in the Department of the Navy. In pursuance of this order a cooperative agreement was worked out under which supervision will be continued by the Geological Survey under the direction of the Secretary of the Interior as to matters of policy. Statistics of the production of petroleum, natural gas, and natural-gas gasoline from naval petroleum reserves are summarized below:

*Petroleum produced from naval petroleum reserves***Total**

Calendar year	Production (barrels)	Royalty oil (barrels)	Royalty value			
			Oil	Gas	Gasoline	Total
-----	1,614,448.12	266,339.59	\$574,166.09	\$4,336.80	\$11,582.71	\$590,085.60
-----	3,863,994.87	1,014,481.32	1,474,669.88	8,440.79	10,511.26	1,493,621.93
-----	9,451,445.67	2,180,574.92	2,173,734.67	64,899.22	57,326.78	2,295,960.67
-----	12,605,519.22	2,863,999.70	2,692,223.03	101,994.76	58,346.08	2,852,563.87
-----	12,870,750.26	3,056,065.95	3,770,876.53	119,199.32	93,818.67	3,983,894.52
-----	12,755,882.16	2,779,100.13	3,310,458.64	114,247.75	152,480.36	3,577,386.66
-----	12,725,365.02	2,902,243.85	3,175,882.25	110,204.62	169,643.75	3,455,730.62
-----	65,886,905.32	15,063,105.46	17,172,200.99	523,323.26	553,609.56	18,249,133.81

By States

la:						
-21-----	1,614,448.12	266,339.59	\$574,166.09	\$4,336.80	\$11,582.71	\$590,085.60
-22-----	3,863,994.87	1,014,481.32	1,474,669.88	8,440.79	10,511.26	1,493,621.93
-23-----	9,034,795.29	2,106,646.04	2,046,619.04	63,770.20	57,198.08	2,167,587.32
-24-----	11,246,134.92	2,678,674.75	2,403,799.27	93,917.00	58,836.98	2,556,063.25
-25-----	12,123,571.89	2,962,668.64	3,628,039.50	117,827.87	93,818.67	3,839,385.74
-26-----	12,234,702.16	2,714,015.11	3,187,461.22	100,089.27	151,296.95	3,438,847.44
-27-----	12,368,315.70	2,857,612.68	3,094,331.59	90,475.99	163,760.36	3,348,567.94
-----	62,485,962.95	14,597,437.13	16,409,086.59	478,557.62	546,505.01	17,434,149.22
lg:						
-23-----	416,650.38	74,229.88	127,105.63	1,129.02	28.66	128,263.30
-24-----	1,359,384.30	188,324.95	288,342.76	8,077.76	9.10	296,510.62
-25-----	747,178.37	93,397.31	142,837.03	1,671.75	None.	144,508.78
-26-----	520,680.00	65,085.02	123,197.32	14,158.48	1,183.41	138,539.21
-27-----	357,049.32	44,631.17	81,550.66	19,728.63	5,883.39	107,162.68
-----	3,400,942.37	465,668.33	763,114.40	44,765.64	7,104.55	814,964.59

ACTIVITIES ON INDIAN LANDS

On behalf of the Office of Indian Affairs the functions of the division include inspectional, regulatory, and advisory service in connection with the leasing of mineral deposits on tribal and restricted Indian lands.

At the end of the year there were outstanding 53 departmental lead and zinc leases on restricted Quapaw Indian lands in Oklahoma covering 7,024.35 acres. The production from these lands amounts to 22 per cent of the zinc and 6 per cent of the lead mined in the United States. The royalty for the fiscal year, amounting to \$1,307,114.54, was 9.25 per cent of the sale value of the ore mined. Four mills on restricted Indian lands introduced desliming and flotation in the treatment of ores during the year, a very large additional recovery of concentrates was obtained from the ores mined, and former waste dumps are being re-treated at a profit. These processes permit the mining of lower-grade ores and greatly increase the potential ore reserves and royalties.

The area of Choctaw and Chickasaw coal and asphalt lands segregated was 441,107.15 acres, of which 112,830.75 acres has been leased; all leases now in effect expire between 1928 and 1932. Congress provided for the disposal of both leased and unleased lands by sale, and during the year two unleased coal tracts containing 1,927.72 acres were sold. There were removed from supervision by the making of final payments seven unleased tracts containing 4,910.93 acres, five leased tracts containing 4,437.40 acres, and three asphalt tracts containing 1,960 acres, a total of 11,308.33 acres. The total area removed from supervision to date is 44,405.70 acres, which is about 10 per cent of the entire segregated area. In addition areas amounting to 32,259.91 acres have been sold but remain under supervisory control because final payments have not been made.

At the end of the year 79 coal leases covering 73,450.60 acres were in force, under 37 of which coal was produced during the year through 60 mines. One lease was canceled during the year. There are 30 suspended and 62 abandoned mines on the segregated leased coal lands. The production of coal for the year from leased and unleased areas was 896,353.21 tons, with a royalty and rental value of \$69,340.73. Only one asphalt lease remains in effect, and it has not been producing.

At the beginning of the year there were 66 coal and asphalt leases on restricted Indian lands comprising 6,493.50 acres. During the year 13 leases comprising 1,263 acres were reinstated, 3 new leases covering 260 acres approved, and 10 leases covering 1,212.50 acres canceled, leaving a total of 72 coal leases covering 7,188.64 acres in effect at the end of the year; 21 of the leases were producing and 51 not producing, as follows:

Coal and asphalt leases on restricted Indian lands

Tribe	Not producing		Producing		
	Num-ber	Advance royalty	Num-ber	Output (tons)	Royalty and rentals
Cherokee.....	6	\$292.50	3	7,840.90	\$622.62
Creek.....	8	203.00	7	12,155.40	1,421.46
Choctaw.....	37	2,258.83	11	138,782.41	14,817.86
	51	2,754.33	21	158,778.71	17,181.94

Of segregated and allotted lands, areas amounting to 25,392 acres were examined geologically to determine their coal value, so that appraisal may be intelligently made when applications are received for sale of restricted lands within the area.

In Oklahoma the supervision of oil and gas activities includes 10,786 leases, covering 1,005,601.04 acres, on which there are 7,748 producing oil and gas wells, summarized by jurisdiction or Indian agencies as follows:

Oil and gas leases in Oklahoma

	Leases		Producing wells		
	Number	Acres	Oil	Gas	Total
Five Civilized Tribes.....	8,804	788,574.00	7,232	298	7,530
Kiowa Indian Agency.....	250	40,604.83	24	6	30
Pawnee Indian Agency.....	328	84,087.99	83	1	84
Ponca Indian Agency.....	847	83,540.35	80	0	80
Shawnee Indian Agency.....	557	58,703.87	21	3	24
	10,786	1,005,601.04	7,440	308	7,748

In addition to the oil leases in Oklahoma aid was given to the Indian Office in supervising oil and gas leases on tribal and restricted allotted Indian lands as follows:

Status of oil and gas leases on Indian land June 30, 1927

	Leases			Wells			
	Produc- ing	Non-produc- ing	Under super- vision	Being drilled	Produc- ing	Aban- doned	Total
Montana:							
Blackfeet, tribal.....	0	2	2	2	0	1	3
Crow, tribal.....	1	3	4		3	12	15
Crow, allotted.....	2	7	9		2	3	5
New Mexico:							
Navajo, tribal.....	3	13	16	7	31	23	61
Wyoming:							
Shoshone, tribal.....				5	41	31	77
Shoshone, allotted.....				1	28	26	55

The following additional mining leases and lease applications were investigated or reported on at the instance of the Indian Office:

California: Tule River Indian Reservation, 1 for limestone; Paiute Indian Reservation, 1 for building stone.

Idaho: Nez Perce Indian Reservation, 3 for limestone.

Nevada: Pyramid Lake Indian Reservation, 1 for lead and silver, 1 for marl.

Oklahoma: Osage Reservation, 1 for lead, gold, and silver.

Wyoming: Shoshone Indian Agency (tribal), 1 for coal; same (allotted), 1 for coal.

OTHER COOPERATIVE WORK

The division cooperated with the Bureau of Mines and Bureau of Standards in connection with tests of mine stoppings to withstand explosions of gas and coal dust; with the Bureau of Mines in its rock-dusting, ventilation, and experimental mine programs; and

through the Bureau of Mines with the Safety in Mines Research Board of Great Britain in the classification of coals on Government lands.

COST OF SUPERVISION AND STATE BENEFITS

Preliminary estimates indicate that the cost of the supervisory work of the mineral-leasing division averages about 2 per cent of the aggregate rents and royalties involved, or only one-fifth of the estimated cost of administration when the leasing law was enacted. This cost for essential engineering supervision is materially less than that of similar supervision of operations under private ownership and is more than covered by the economies effected and reflected in immediate royalty returns. The future values preserved by conservation measures established by the supervisory forces and the eventual royalties to be derived therefrom far exceed the current monetary returns from the work of the division.

Twenty-three States and Alaska are directly interested in the results of mineral leasing on public lands, as they receive without expense to themselves 37.5 per cent of all royalties and rentals, and 52.5 per cent is spent in these States through the Bureau of Reclamation.

WORK ON PUBLICATIONS

BOOK PUBLICATION

TEXTS

During the year 21,377 pages of manuscript were edited and prepared for printing by the section of texts, and proof sheets comprising 1,832 galley proofs and 14,280 page proofs were read and corrected. Indexes were prepared for 32 publications covering 5,214 pages. Copy and proof or stencils for 922 pages of multi-graph and mimeograph matter were read. At the end of the fiscal year five persons were employed in this section.

ILLUSTRATIONS

The number of drawings prepared by the section of illustrations was 2,500, including 184 maps, 582 sections and diagrams, 624 photographs, and 1,110 paleontologic drawings; 170 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany 35 reports numbered 639, to be reproduced by chromolithography, photolithography, halftone, and zinc etching. The number of proofs received and examined was 1,964. At the end of the year material for illustrating 48 reports is in hand. The section now consists of 11 employees.

MAP EDITING

GEOLOGIC EDITING AND DRAFTING OF MAPS AND ILLUSTRATIONS

Maps and illustrations for 31 geologic reports were drawn and prepared for geologists in the geologic branch. The geologic map of Oklahoma was published. Progress was made on the color-stone

work of the New Mexico geologic map. Compilation of the geologic map of Texas and of the map of the United States was begun.

The maps of the Bessemer-Vandiver (Ala.) folio were ready for printing at the end of the year. The maps of the Coatesville-West Chester (Pa.) and of the Gaffney-Kings Mountain (S. C.-N. C.) folios were sent for transfer to stone. Engraving of the Fairfield-Gettysburg (Pa.) and Somerset-Windber (Pa.) maps was begun. The Montevallo-Columbiana (Ala.) and Hollidaysburg-Huntingdon (Pa.) folios were partly prepared for engraving. The Boston (Mass.) folio was received for publication and its preparation begun.

Maps and illustrations for 30 reports besides folios were edited during the year.

INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

During the year 122 new topographic maps were edited and transmitted for engraving; 185 published topographic maps, 9 State maps, and 8 State index circulars were edited for reprint; 12 plan and profile river-survey sheets were edited for photolithography; 7 miscellaneous maps were edited for engraving or photolithography; and 492 maps were edited as illustrations for Geological Survey reports—a total of 835 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 429 and proofs of maps reproduced by photolithography numbering 182 were read. At the end of the year 138 new topographic maps were in progress of engraving and printing and 120 new topographic maps and projects were in preparation for submission for reproduction.

DISTRIBUTION

A total of 318 publications, comprising 64 new books and pamphlets, 1 reprinted book, 1 new geologic folio, 112 new or revised topographic and other maps, and 140 reprinted topographic and other maps were received by the division of distribution during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 179,355 books and pamphlets, 8,785 geologic folios, and 644,750 topographic and other maps, a grand total of 832,890.

The division distributed 198,584 books, 9,438 folios, and 742,818 maps, a total of 950,840, of which 8,023 folios and 609,148 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$46,116.32, including \$40,779.28 for topographic and geologic maps and \$5,337.04 for geologic folios. In addition to this \$984.52 was repaid by other Government establishments at whose request maps or folios were furnished. The total receipts, therefore, were \$47,100.84.

The division received and answered 88,238 letters.

ENGRAVING AND PRINTING

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the year 72 new topographic maps were engraved and printed, including 14 revised maps. Forty new maps were photolithographed and printed, making a total of 112 new maps printed

and delivered. Corrections were engraved on the plates of 166 maps. Reprint editions of 135 engraved topographic maps and 5 photolithographed State and other maps were printed and delivered. In addition 58 new topographic maps had been engraved and were in press June 30, and the engraving of 18 other new topographic maps was nearly completed. Of new and reprinted maps 256 different editions, amounting to 644,750 copies, were delivered. One new geologic folio was printed, its edition amounting to 8,785 copies.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, office of the Secretary of the Interior, Bureau of Mines, Bureau of Reclamation, Bureau of Education, General Land Office, National Park Service, Office of Indian Affairs, Alaska Railroad, Bureau of Public Roads, Bureau of Agricultural Economics, Bureau of Plant Industry, Bureau of Biological Survey, Forest Service, Weather Bureau, Bureau of Standards, Bureau of Lighthouses, Bureau of Navigation, Department of Labor, Department of State, War Department, Post Office Department, Treasury Department, Department of Justice, Department of Commerce, Interstate Commerce Commission, Federal Power Commission, Public Buildings Commission, Commission of Fine Arts, Smithsonian Institution, National Research Council, Coast Guard, Bureau of Internal Revenue, Veterans' Bureau, Federal Board for Vocational Education, Engineer Map Reproduction Plant, National Sesquicentennial Exposition, Pan-Pacific Conference, American Red Cross, Purdue University, Regional Plan of New York and its Environs, and the States of Alabama, Idaho, Kansas, Missouri, New Hampshire, Oklahoma, and West Virginia. This work done for other branches of the Government and State governments included many reprints, and the charges for it amounted to about \$140,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the Treasury Department. Transfer impressions numbering 165 were made during the year, including 69 furnished to contracting lithographic printers on requisition of the Government Printing Office, 47 furnished to private firms, 47 furnished to the War Department, and 2 furnished to the Weather Bureau. Other miscellaneous work was done for A. Hoen & Co., Heliotype Co., Dennison Manufacturing Co., Williams & Heintz Co., Mrs. Charles S. Fayerweather, Clark University, University of Texas, and North Dakota Agricultural College. The amount turned over to miscellaneous receipts from this work was \$210.75.

Of contract and miscellaneous work of all kinds 2,902,551 copies were printed. Including topographic maps and geologic folios, a grand total of 3,556,086 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 8,503 negatives (1,853 wet, of which 840 were for photolithographs, 129 paper, 2,238 dry, 3,752 field negatives developed, and 531 lantern slides), 54,295 prints (26,219 maps and diagrams and 28,076 photographs for

illustrations), 2,700 zinc plates, 292 zinc etchings, 77 celluloid prints, 97 lantern slides colored, 9 transparencies colored, 43 prints colored, 5 crayons colored, and 3,247 prints mounted.

ADMINISTRATION

CORRESPONDENCE AND RECORDS

The work of the section of correspondence and records was of the same general character as during the preceding fiscal year. At the end of the year the appointees of the Secretary numbered 836, 10 less than at the end of the fiscal year 1926. The changes in personnel were 683, including 118 appointments, 128 separations, and 437 miscellaneous. During the calendar year 1926, 72 per cent of the possible annual leave and 15 per cent of the possible sick leave was granted. Leave without pay and furloughs amounting to 4,320 days were also granted.

LIBRARY

Accessions to the library numbered 17,737 books, pamphlets, and periodicals and 755 maps. The recorded loans were 6,265 books and 132 maps, not including those used by 10,893 readers who consulted the library in person. The catalogue was increased by the addition of 3,104 cards. In accordance with the cooperative cataloguing arrangements, 665 title entries were furnished to the Library of Congress for printing, the proof reading of which involved 87 galleys.

The correspondence, consisting of 2,132 letters written and 1,682 received, largely concerned the exchange of publications. This correspondence involved the translation of many letters in foreign languages. Foreign articles and letters translated for other divisions of the Geological Survey numbered 205. There were 917 books collated and prepared for binding and 666 newly bound books accessioned and labeled.

Cooperation in the compilation of the "Union list of serials in the libraries of the United States and Canada," to be published under the auspices of the American Library Association, was continued.

The proof of the bibliography of North American geology for 1923 and 1924 (Bulletin 784) was read, and the preparation of the bibliography for 1925 and 1926 was continued.

ACCOUNTS

Condensed statements covering the expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

*Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ending June 30, 1927.**

Appropriation	Funds available				Expenditures			Balance
	Amount of appropriation	Repayments on account of work performed		Total	Disbursements	Outstanding liabilities	Total	
		For cooperating agencies						
		Made	To be made					
Salaries.....	\$130,000.00	\$108,323.48	\$23,253.73	\$130,000.00	\$126,733.17	\$3,556.23	\$126,733.17	\$3,266.83
Topographic surveys.....	451,700.00	15,870.39	5,888.79	657,726.78	647,884.06	5,271.89	650,941.20	6,785.58
Geologic surveys.....	337,160.00	33.44		359,395.59	346,180.48	21,777.17	351,452.37	7,943.22
Volcanologic surveys.....	25,000.00	43.70		25,033.44	21,777.17	5,853.59	24,630.76	402.68
Mineral resources of Alaska.....	50,000.00	107,357.42	22,739.10	50,407.16	44,581.00	5,609.92	50,190.92	216.24
Gaging streams.....	151,000.00	131,000.00	2,468.79	283,565.31	277,862.64	2,716.63	280,579.27	2,986.04
Classification of lands.....	240,000.00	998.37	218.96	242,524.83	234,674.30	3,685.40	238,359.70	4,165.13
Geologic maps of the United States.....	97,000.00	100,547.23	18,011.07	237,708.97	203,873.06	31,064.35	234,937.41	2,772.56
Preparation of illustrations.....	25,560.00	23.48	19.20	25,622.68	25,008.12		25,008.12	613.56
Mineral leasing.....	312,000.00	4.35	304.07	312,308.42	280,061.73	10,067.29	290,129.02	22,179.40
	1,819,440.00	393,201.85	70,111.65	2,324,294.18	2,209,137.65	64,825.29	2,273,962.94	451,331.24

* In addition to these appropriations, items of \$81,000 for printing and binding Geological Survey publications and \$11,000 for miscellaneous printing and binding were contained in the appropriation act, but the accounts for these items were not kept in the Geological Survey. There was also an allotment of \$13,707 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

* Of these totals \$6,177 is in the hands of special disbursing agents and therefore has not been included in the classification of expenditures, as no vouchers covering disbursements have been received.

* Included in this amount is \$41,540.08 covering work performed by Geological Survey units for other Geological Survey units, necessarily reported in combining totals, but otherwise a duplication.

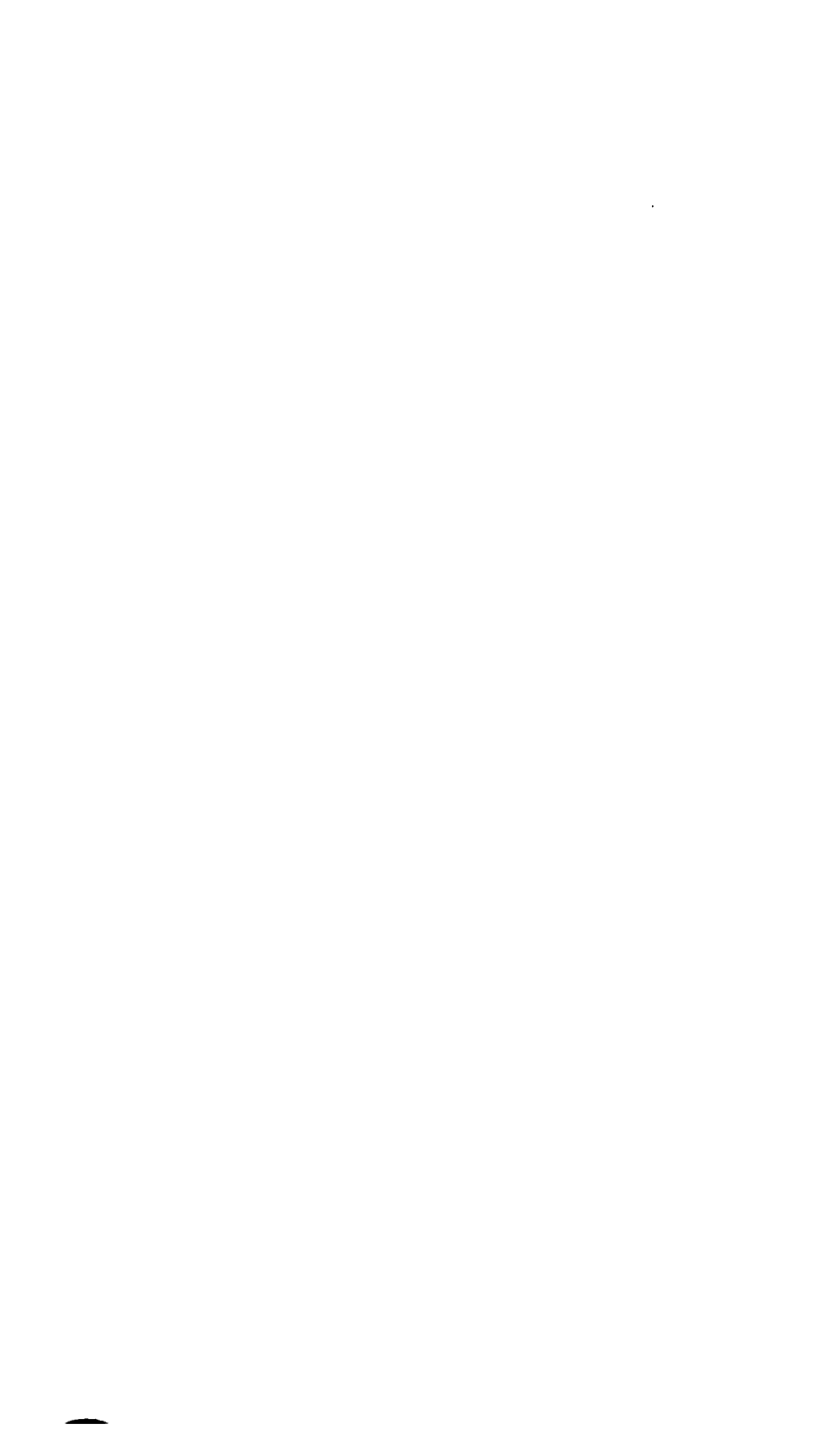
* A budget reserve of \$26,620 is included in this balance.

SUBDIVISIONS	SURVEYS	DATE 1900	DATE 1901	DATE 1902	DATE 1903	STATES	LIABILITIES	TOTAL
Personal services.....	\$126,733.17	\$126,733.17	\$126,733.17	\$126,733.17	\$126,733.17	\$126,733.17	\$126,733.17	\$126,733.17
Stationery and office supplies.....	8,282.70	8,282.70	8,282.70	8,282.70	8,282.70	8,282.70	8,282.70	8,282.70
Scientific and educational supplies.....	3,011.95	3,011.95	3,011.95	3,011.95	3,011.95	3,011.95	3,011.95	3,011.95
Sundry supplies.....	1,026.20	1,026.20	1,026.20	1,026.20	1,026.20	1,026.20	1,026.20	1,026.20
Subsistence and care of animals and storage and care of vehicles.....	573.22	573.22	573.22	573.22	573.22	573.22	573.22	573.22
Telephone service.....	170.71	170.71	170.71	170.71	170.71	170.71	170.71	170.71
Other communication service.....	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70
Travel expenses.....	74,030.19	74,030.19	74,030.19	74,030.19	74,030.19	74,030.19	74,030.19	74,030.19
Attendance at meetings.....	463.29	463.29	463.29	463.29	463.29	463.29	463.29	463.29
Hire, maintenance, operation, and repair of horse-drawn and motor-propelled passenger-carrying vehicles.....	5,719.10	5,719.10	5,719.10	5,719.10	5,719.10	5,719.10	5,719.10	5,719.10
Transportation of things.....	32,148.75	32,148.75	32,148.75	32,148.75	32,148.75	32,148.75	32,148.75	32,148.75
Lithographing, engraving, and engrossing.....	11,743.73	11,743.73	11,743.73	11,743.73	11,743.73	11,743.73	11,743.73	11,743.73
Stenographic work, typewriting, and duplicating work, etc. (job work).....	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75
Photographing and making photographs and prints.....	2,885.66	2,885.66	2,885.66	2,885.66	2,885.66	2,885.66	2,885.66	2,885.66
Heat, light, power, water, and electricity.....	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40
Rents.....	99.24	99.24	99.24	99.24	99.24	99.24	99.24	99.24
Repairs and alterations.....	125.43	125.43	125.43	125.43	125.43	125.43	125.43	125.43
Special and miscellaneous current expenses.....	13,743.91	13,743.91	13,743.91	13,743.91	13,743.91	13,743.91	13,743.91	13,743.91
Purchase of passenger-carrying vehicles.....	710.00	710.00	710.00	710.00	710.00	710.00	710.00	710.00
Furniture, furnishings, and fixtures.....	839.16	839.16	839.16	839.16	839.16	839.16	839.16	839.16
Educational and scientific equipment.....	5,490.22	5,490.22	5,490.22	5,490.22	5,490.22	5,490.22	5,490.22	5,490.22
Livestock.....	11,837.20	11,837.20	11,837.20	11,837.20	11,837.20	11,837.20	11,837.20	11,837.20
Other equipment.....	1,531.81	1,531.81	1,531.81	1,531.81	1,531.81	1,531.81	1,531.81	1,531.81
Miscellaneous transfers and adjustments.....	126,733.17	126,733.17	126,733.17	126,733.17	126,733.17	126,733.17	126,733.17	126,733.17

GEORGE OTIS SMITH,
Director.

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U. S. DEPARTMENT OF THE INTERIOR

*ANNUAL REPORT OF THE
DIRECTOR OF
THE GEOLOGICAL SURVEY
TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1928*



U. S. DEPARTMENT OF THE INTERIOR

FORTY-NINTH ANNUAL REPORT

OF THE

*DIRECTOR OF
THE GEOLOGICAL SURVEY*

TO THE

SECRETARY OF THE INTERIOR

1928



*UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON*

1928

Directors of the Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907

GEORGE OTIS SMITH, 1907-

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N.S. Grant.
777
1-22-1929

ANNUAL REPORT OF THE DIRECTOR OF THE GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 15, 1928.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1928 included 10 items, amounting to \$1,807,880. In addition \$109,000 was appropriated for printing the reports of the Geological Survey, and \$11,000 for miscellaneous printing and binding, and an allotment of \$15,763.95 for miscellaneous supplies was made from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of this report. The balance on August 30, including a budget reserve of \$850, was \$28,301.48.

The total amount of funds made available for disbursement by the Geological Survey, together with State funds directly disbursed for work administered by the Federal officials, was \$2,909,170.

MEETING THE DEMAND

The function of consulting geologist or hydraulic engineer to the public is one that exposes the Geological Survey to a decidedly increasing demand that is gratifying, even though embarrassing. The growing interest in the great public projects of completing the topographic map of the country and of making an inventory of its water resources is demonstrated by the larger amount of cooperative funds contributed by the States to the mapping and investigative program of the Federal Geological Survey. This year such contributions, coming from 38 States and Hawaii, exceeded three-quarters of a million dollars.

Another item expressing the augmented extent and scope of work administered by the Geological Survey includes the funds transferred to it from other Federal agencies for technical services rendered. This item exceeded one-third of a million dollars in the fiscal year 1928, showing an increase of 10 per cent over the preceding year. The volume of work to be requested by other Federal agencies is always difficult to forecast, but these recent years indicate the general need of the type of investigations for which a corps of trained specialists is available.

Another index of increasing demand is afforded by the number of visitors to the principal local offices of the Geological Survey in the

West. These offices at Denver, Salt Lake City, San Francisco, and Los Angeles make a special effort to answer all inquiries for geologic and engineering information, whether included in published reports or not, and this year they served 8,464 callers, an increase of nearly 10 per cent over the preceding year. General correspondence between the public and the Washington office increased 5 per cent, as did also the distribution of publications on specific request. As in other recent years, the number of both books and maps distributed has exceeded the number printed in the same period, proving that there is no accumulation of dead stock on the shelves. Especially notable was the increase of nearly 15 per cent in the sales of maps. In the distribution of its publications the Geological Survey is a going concern.

A less tangible measure of appreciation of the country's need of surveys and investigations of the type in which the Geological Survey is engaged is afforded by the general demand for an increase in such work. In recent months the chambers of commerce and mining and development associations in the West and the engineering societies of the whole country have called attention to the increasing need of Federal investigations in aid of mining and other development, characterizing the Geological Survey's half century of service in aiding "in finding, developing, and conserving the natural resources of our country" as a fundamental and indispensable contribution to the mining industry.

The fact that too often escapes notice is that the present high-pressure industrial development throughout the country involves an ever greater demand for raw materials as well as for the basic engineering information required in the great constructive undertakings by private enterprise and by the Government itself.

It is difficult to appreciate the full scope of developmental activity that calls for the investigative work by the Government scientific bureaus. Where the topographic map once served a single purpose it is now utilized in a dozen ways; similarly, exact information regarding water resources, both surface and underground, is demanded by State and municipal officials and by the promoters of industrial and agricultural projects. The need of geologic investigation is possibly even greater, in view of the present magnitude of the output of the mines and oil wells of the country. In its growth in volume of output the mining industry stands by itself, but in the process of furnishing the needed raw materials to other industries in rapidly increasing quantities mines and wells become more rapidly exhausted and new deposits must be found. Thus arises the demand for more and better geology, as voiced in the many expressions of public opinion from the mining centers of the country. The United States Geological Survey is being called to take the lead in an intensive study directed to the finding of ore in order to forestall any serious decline in the needed supply of the metals and other essential minerals, with the consequent slowing down of all industry. The premise commonly mentioned in these requests for increased activity is the recognized pioneer work by the geologists and engineers in the earlier decades of developmental progress in the Western States.

THE YEAR'S OPERATIONS

The director continued his service as chairman of the advisory committee of the Federal Oil Conservation Board and as chairman of the Naval Oil Reserve Commission. In connection with his administration of the general work of the Geological Survey he made addresses and informal talks and contributed articles to the press, all with the purpose of helping to bring before the public the results of the work of his associates. A list of these addresses and articles follows:

- Need of Facts, Western Society of Engineers, Chicago, December 12.
- Charles D. Walcott and the United States Geological Survey, National Museum auditorium, Washington, January 24.
- Canada—Its Natural Wealth, Canadian Institute of Mining and Metallurgy, Quebec, March 9.
- Engineer-Citizens, Lehigh Valley Mineral Industry Conference, Easton, Pa., April 28.
- Your Future, commencement address at Colorado School of Mines, Golden, May 18.
- America in High, commencement address at Colby College, Waterville, Me., June 18.
- Coal—the Premier Source of Energy, Coal Age, July.
- Charles D. Walcott, American Journal of Science, July.
- Work of United States Geological Survey as Related to the Mining Industry, Mining Congress Journal, February.
- One Step in Production Control, Mining and Metallurgy, May.
- Federal Cooperation with the States, United States Daily, June 28.

In recognition of the Geological Survey's long service to the mining industry, the director was elected president of the American Institute of Mining and Metallurgical Engineers in February, and between that time and July he attended meetings of mining men in eight States.

The branch chiefs also represented the Geological Survey at technical or other meetings and spoke on various subjects, a few of which are listed below:

- Geology and Mining, by W. C. Mendenhall, American Mining Congress, December 3.
- Outfitting Alaska Expeditions, by Philip S. Smith, Harvard Club, April 14.
- The Alaskan Branch of the Geological Survey, by Philip S. Smith, American Mining Congress, December 3.
- Topographic Mapping in Connection with Flood Control, by C. H. Birdseye, Arkansas and Red River Flood Control Convention, Oklahoma City, Okla., December 1.
- Topographic Mapping of the United States, by C. H. Birdseye, Western Society of Engineers, Chicago, December 12.
- Colorado River, by C. H. Birdseye, student section, American Society of Civil Engineers, George Washington University, Washington, January 6.
- Story of Topography, by C. H. Birdseye, Society of Engineers, Atlanta, Ga., February 6.
- Run-off Characteristics of the Mississippi River Discharge Basin, by N. C. Grover, American Society of Civil Engineers, Columbus, Ohio, October, 1927.
- River Flow Observations and Their Significance, by N. C. Grover, Southern Appalachian Power Conference, Chattanooga, Tenn., October, 1927.
- The Recording of River Discharge, by N. C. Grover, Military Engineer, April-May, 1928, p. 120.
- A Nation's Water Power, by Herman Stabler, Economic Geography, volume 3, No. 4, October, 1927.

A brief summary of the work done by the Geological Survey during the fiscal year is given in the following paragraphs:

GEOLOGIC WORK

Geologic work was done in 43 States, Alaska, and the District of Columbia. In this work 16 of the States cooperated. The cooperative work takes a variety of forms but consists mainly of the study of specific problems on a cost-sharing basis. Among the results of such work are contributions to proposed geologic maps of Arkansas, Florida, Pennsylvania, Texas, and Virginia. Considerable geologic work was also done in cooperation with other Government organizations and with nongovernmental scientific associations. Cooperative investigations bearing on oil and gas resources were made in 1 State, on metalliferous deposits in 5 States, on potash in 2 States, on coal in 3 States, and on general geologic problems in 17 States. The investigations in search of potash, carried on in cooperation with the Bureau of Mines, centered largely in Texas, where three sites for core drilling were selected and the drilling at five other sites was completed. The cores were studied and selected portions analyzed, and preliminary reports on the economic results were prepared. Volcanologic studies were carried on in California, Alaska, and Hawaii. Numerous paleontologic determinations were made. Investigations of ore deposits, coal, oil shale, and other minerals and studies in glacial geology, stratigraphy, and structure were continued. In the chemical laboratory 5,627 samples of potash salts were examined and 71 specimens submitted in connection with specific problems were subjected to special examinations and tests; 2,055 specimens were identified for private persons. Further work was done on problems connected with petroleum recovery.

EXPLORATIONS IN ALASKA

The principal explorations conducted by the Geological Survey in Alaska in the field season of 1927 were made in the Copper River region, the northeastern part of the Yukon Basin, and the Mount Spurr region of the Alaska Range. The work in the Yukon Basin resulted in 3,700 square miles of geologic mapping and 4,900 square miles of topographic mapping of previously unmapped country, also a geologic resurvey with greater precision of 300 square miles. The Mount Spurr expedition accomplished the topographic mapping of 2,265 square miles and the geologic mapping of 2,000 square miles of new country. The compilation of the aerial photographs of southeastern Alaska taken by the Navy Department at the request of the Geological Survey was continued, and a drainage map of a tract of about 2,000 square miles in this region was completed.

Six field projects were in progress at the end of the fiscal year 1928, including reconnaissance and detailed topographic mapping in southeastern Alaska, geologic reconnaissance in the Copper River, upper Tanana, and Yukon regions, and geologic and topographic reconnaissance in the Alaska Range. Some of the work in southeastern Alaska is being done for the Forest Service, which is bearing the cost. Airplanes were used to cooperate in transporting part of the supplies and equipment used by the party surveying in the Alaska Range. The supervision of operations under leases issued by the Government for extracting coal and oil on public lands was continued during the year, a small staff being maintained at two local offices in Alaska for this purpose.

TOPOGRAPHIC MAPPING

The topographic work was done in cooperation with 26 States, and the area mapped amounted to 17,721 square miles in 34 States, the District of Columbia, and Hawaii. Of this total 13,777 square miles represents new surveys, 2,407 square miles resurveys, and 1,537 square miles revisions. The total area mapped to June 30, 1928, is 1,314,316 square miles. Nine States and the District of Columbia are now entirely mapped, and the percentages in the other States range from 8 to 88.4. Of the total continental United States, exclusive of Alaska, 43.2 per cent has been mapped. River surveys amounting to 14 linear miles and 101 square miles were also made. In connection with the topographic work 6,272 miles of spirit levels and 4,046 miles of transit traverse were run and 157 triangulation stations were occupied. Cooperation was continued with the Air Corps, United States Army, whereby aerial photographs were furnished for use in topographic mapping. A shaded relief and highway map of New Hampshire and a contour map of Virginia were compiled in cooperation with the respective States.

INVESTIGATIONS OF WATER RESOURCES

The work on water resources is done largely in cooperation with other Federal bureaus, with State, county, and municipal agencies, and with permittees and licensees of the Federal Power Commission. The amount expended by State, county, and municipal agencies for such work during the year, in part directly and in part through the Geological Survey, was \$338,819. This sum covered work in 31 States and Hawaii. Including the cooperative work, the study of surface waters, which consists primarily of the measurement of the flow of streams, was carried on in 42 States and Hawaii, in which at the end of the year 1,830 gaging stations were being maintained. The work on ground-water resources has been planned to meet the more and more exacting public demand for precise information with increasing need for the water. Investigations relating to ground water and reservoir sites were made in 15 States. Research into the principles of hydrology has been continued in order to provide a more secure basis for ground-water investigations. A hydrologic laboratory and three experiment stations have been maintained, 30 automatic water-stage recorders have been installed over observation wells, and thousands of measurements of water levels in wells have been made. Cooperation was continued with well drillers' associations with a view to developing higher standards and better results in water-well drilling. The work on quality of water involved the examination of 801 samples. The investigations of power resources included the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants. A report on the developed and potential water power of the United States was published.

WORK IN CLASSIFYING AND LEASING PUBLIC LAND

The work of classifying public and Indian lands with respect to mineral content and of supervising mineral operations on such lands was carried on in 21 States and Alaska. The number of cases involving land classification acted on during the year was 19,956, and the results accomplished include net decreases of 720 acres in the area of outstanding coal withdrawals, of 3,960 acres in outstanding petroleum withdrawals, and of 13,276 acres in outstanding phosphate reserves. At the end of the year the total area classified as mineral in character amounted to 36,488,995 acres in 14 States and Alaska and the outstanding mineral withdrawals to 44,951,277 acres in 14 States. Definition of the "known geologic structure" of producing oil and gas fields was continued, and at the end of the year the net area so defined was 517,745 acres in seven States. Investigations to obtain information for classifying public land with respect to its value for the development of water power were made in four States. There was a net increase of 143,754 acres in the area included in power reserves, making a total of 6,233,762 acres in 20 States and Alaska, on which about 15,000,000 continuous horsepower can be developed. The net increase in enlarged-homestead designations was 476,900 acres, making a total outstanding of 325,159,793 acres in 14 States, and the net increase in stock-raising homestead designations was 1,023,934 acres, making a total outstanding of 119,124,604 acres in 18 States. There was a net increase of 37,814 acres in public water reserves, and the total outstanding is now 403,391 acres in 12 States. The supervisory work on public lands subject to the mineral leasing laws was increased between 10 and 12 per cent by the receipt of 85 leases, 4,588 permits, and 8 licenses, covering 7,910,582.60 acres. The production of petroleum on such lands during the year was 23,370,549.38 barrels, on which the oil, gas, and gasoline royalty value was \$3,735,451.41. The production of coal on such lands was 3,000,248.38 tons, of phosphate rock 23,459.95 tons, and of sodium 16,127.99 tons, on which the royalty rentals and bonuses amounted to \$387,307.10. Supervision over oil and gas operations on naval petroleum reserves was continued, and the petroleum produced amounted to 9,839,859.19 barrels, on which the oil, gas, and gasoline royalty value was \$2,232,375.39. Inspectional, regulatory, and advisory service was rendered in connection with the leasing of mineral deposits on Indian lands in eight States, with a royalty value of over \$7,000,000, nearly all in Oklahoma.

PUBLICATIONS

The publications of the year consisted of 53 books and pamphlets of the regular series (including 5 reprints), 150 new or revised maps, 165 reprinted maps, and numerous circulars, lists of publications, etc. The total number of pages in the new book publications was 5,639. In addition to the publica-

tions in the regular series, 94 brief reports were issued in mimeographed form as memoranda for the press. The manuscript edited and prepared for printing amounted to 23,193 pages; 2,686 galley proofs and 11,260 page proofs were read and corrected. Indexes were prepared for 24 publications, covering 5,670 pages. The drawings prepared for publications numbered 2,605, and the proofs of illustrations examined 1,423. Maps for 2 folios were wholly or partly prepared for engraving, and maps and illustrations for 47 other reports were edited. The new topographic maps edited and transmitted for engraving numbered 86, and 706 other maps were edited. Map proofs numbering 755 were read. Of new and reprinted maps and folios 748,860 copies were printed. The publications distributed numbered 1,006,888, of which 5,111 folios and 699,365 maps were sold for \$48,762.35.

GEOLOGIC BRANCH

W. C. MENDENHALL, *Chief Geologist*

ORGANIZATION

The work of the geologic branch has been administered during the year through 10 units, representing topical or geographic groupings of activities. These units are as follows:

Paleontology and stratigraphy, T. W. Stanton, geologist in charge.
 Geology of metalliferous deposits, G. F. Loughlin, geologist in charge.
 Areal geology and geology of nonmetalliferous deposits, G. R. Mansfield, geologist in charge.
 Geology of iron and steel metals, E. F. Burchard, geologist in charge.
 Glacial geology, W. C. Alden, geologist in charge.
 Coastal Plain investigations, L. W. Stephenson, geologist in charge.
 Geology of fuels, H. D. Miser, geologist in charge.
 Volcanology, T. A. Jaggar, jr., volcanologist in charge.
 Petrology, C. S. Ross, geologist in charge.
 Chemistry and physics, George Steiger, chemist in charge.

The sections of areal geology and nonmetalliferous deposits were combined on July 15, 1927, under G. R. Mansfield. H. D. Miser succeeded W. T. Thom, jr., as geologist in charge of the section of geology of fuels.

The professional force was reduced by two deaths, one transfer, and two resignations. With these changes it now includes 98 geologists of different grades, 8 chemists, 2 physicists, 1 laboratory aide, and 1 topographic engineer. Six draftsmen (2 temporary) and 6 preparators of fossils (1 temporary—1 temporary preparator of fossils having died during the year) constitute the subprofessional force. In the clerical force there were 4 accessions (3 appointed for field offices) and 3 separations (1 from field office), 1 by retirement and 2 by resignation, leaving a total of 31 clerks of various grades, 5 of whom are temporary.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the geologic branch for the fiscal year were as follows:

Geologic surveys.....	\$328, 200
Classification of lands.....	31, 000
Volcanologic surveys.....	20, 000
Investigating potash deposits.....	9, 750
Repayments from other Federal departments.....	617
Repayments from State, city, and other cooperating organizations.....	22, 798
	<hr/>
	412, 365

The expenditures from these funds may be classified approximately as follows:

Geologic investigations (economic and scientific)-----	\$304, 915
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc-----	82, 000
Hawaiian volcanology-----	19, 450
Budget reserve and unexpended balances-----	6, 000
	<hr/> 412, 365

GOVERNMENT GEOLOGIC WORK AND ITS USES

Geology is one of the fundamental physical sciences. It deals with the origin of the earth, with its extinct life, with the growth of its mountain chains, its continents, and its oceans, and with its composition, including substances in and on the earth—soils, metals, building materials, fertilizers, coal, oil, and water—upon which man so largely depends. All of our important educational institutions teach geology, for it is both a practical and a cultural science. It is a part of every balanced curriculum, because it is basic in man's understanding of his relations to things about him.

The chief foundation of the textbooks on the geology of the United States and the largest single source of material for the teacher of geology in this country is either directly or indirectly the 1,500 or more volumes issued by the United States Geological Survey. These volumes present the results of original studies. Each contributes to our knowledge of the earth which we inhabit. New reports and maps are sought constantly for educational purposes, and old reports are in continual use. From the institutions of learning throughout the country, therefore, come steady demands for more material. With the increased costs and the decreased appropriations of late years and the consequently lessened output of such teaching material, there have come complaints and criticisms. Geologic folios and other geologic reports are badly needed. Few are available. The stream of educational material in this field is being dried up at its source. This situation needs prompt correction by adequate support of Government research in geology for the benefit of the educational institutions of the country.

There are, indeed, few industries in the United States that are not dependent upon materials with which the science of geology is concerned. Mining, of course, deals directly with ores and minerals. Coal, oil, iron, copper, lead, zinc, aluminum, gold and silver, quicksilver—all come from the crust of the earth. Building materials (granite, marble, concrete, brick, pottery), the fertilizers (potash, phosphates, and nitrates), many of the substances used in paints and varnishes, jewels and precious stones—all have the same source. And nearly all industries depend upon these mineral substances. There could not be a railroad or a train to run over it, nor an automobile, a steamship, a telegraph or telephone line, a radio or an airplane, or even a modern building, without the use of geologic materials, the ores of the earth.

The uses of all these materials are increasing as man closes in on the waste spaces of the world and lives more intensively in the settled places. Some of them are to be had in abundance, some are limited in quantity and are definitely exhaustible or are being ex-

hausted. The search for them becomes constantly more intense, and all of man's resourcefulness, all of the energy, and all of the science of which he is master are needed to find new supplies to satisfy modern needs. The trends of colonization and settlement, the issues of peace and war, have been vitally affected by the presence or absence of these mineral resources, and civilizations have waned as the supplies have diminished.

The average citizen knows little of the complicated chain of linked and correlated human endeavor that lies back of the satisfaction of his simplest needs. He buys 5 gallons of gasoline. Ten years before, perhaps, a group of geologists explored western Texas or northern Montana or central Wyoming. After examining many hundreds of square miles, favorable geologic conditions were found, and an area was recommended for drilling. Eventually it was drilled, oil was discovered, pipe lines and refineries were built, and distribution was effected. Thus the citizen was enabled to drive another hundred miles without a thought as to how it all happened. But back of it was the essential but forgotten geologic work.

All of this is going on to-day so that man's needs may continue to be satisfied ten or a hundred years hence. The men who must win the ores or the mineral substances know the burden that is on them to do their share in maintaining modern civilization. The rest of us do not. But those who have the vision, those who do know, want geologic work done—not less but more. They want the help that geologic maps, geologic research, geologic understanding can give in finding the mineral bases of modern life. Giving this aid constitutes the economic use of geology. The Government is properly expected to do its share in this work for all of its citizens. It is looked to, not to apply geologic principles to specific problems, such as to digging coal or mining copper—that is the field of the practicing geologist and the mining engineer—but to establish the principles ready for application, to supply the general maps, to determine the rock succession, the broad relations and habits of ores, and the laws of their occurrence, and thus to guide exploration from hopeless into hopeful areas.

There can be no applied science unless there is science to apply. The application of science, geologic or other, depends upon the maintenance of research, for it is pure research that discovers new facts and new natural laws that can be put to use. Every active scientific organization, therefore, is continuously engaged in research whose direct applicability to human use may not be manifest at the moment. Thus the Geological Survey staff is constantly engaged in geologic research—always in connection with its individual projects, for each study, however practical its purpose, involves research, but often in fields not ordinarily called practical. Paleontology—the study of fossils, in itself a purely scientific study—has been found to have such direct practical applications that purely commercial institutions, like oil companies, now have staffs of paleontologists, but the value of their work depends upon broader studies than they are usually able to make, and the Geological Survey should be supplying them, much more adequately than it is, with reference material.

Even the study of earth temperatures, entered upon as an abstract science, is developing interesting possibilities in oil-field work. Simi-

larly studies in the alteration of ore bodies and in their distribution, zonal or other, lead to conclusions that are most definitely applicable and are applied in mining. Great mining companies base decisions involving the expenditure of millions upon the results of such scientific studies. The Government has been and should continue to be the leader in this work; otherwise it will not be adequately or systematically done, and the cost of its neglect to the people and the industries of the country is beyond reckoning.

Work covering broad fields of research or areas not confined to States was conducted by many of the geologists and paleontologists, and the results of some of these studies have been submitted for publication by the Geological Survey or through unofficial channels. In the following list the first two papers were submitted for publication in the Shorter Contributions to General Geology, and the remainder for outside publication:

- Exogyra olisiponensis* Sharpe and *Exogyra costata*, by J. B. Reeside, jr. Additions to the flora of the Green River formation, by Roland W. Brown. Glacial epoch in North America, by Frank Leverett. For volume on North America in *Geologie der Erde*.
- The Lower Cretaceous or Comanche series, by T. W. Stanton. *American Journal of Science*.
- An *Acanthoceras rhotomagense* fauna in the Cretaceous of the Western Interior, by J. B. Reeside, jr. *Journal of the Washington Academy of Sciences*.
- Two new unionid pelecypods from the Upper Triassic, by J. B. Reeside, jr. *Journal of the Washington Academy of Sciences*.
- Triassic-Jurassic "Red Beds" of the Rocky Mountain region, by J. B. Reeside, jr. *Journal of Geology*.
- Pycnodema* nom. nov. pro *Pycnodema* Kirk non Schrammen, by Edwin Kirk. *Proceedings of the United States National Museum*.
- The crinoid genus *Vasocrinus* Lyon, by Edwin Kirk. *Proceedings of the United States National Museum*.
- Cryphiocrinus*, a new genus of free-swimming crinoids, by Edwin Kirk. *American Journal of Science*.
- Bathmopterus*, a new gastropod genus from the Silurian of Alaska, by Edwin Kirk. *Proceedings of the United States National Museum*.
- On the generic name *Orbiculoidea* D'Orbigny and its application, by G. H. Girty. *Journal of the Washington Academy of Sciences*.
- Stones of *Celtis* in the Tertiary of the western United States, by E. W. Berry. Distribution in tropical America of *Turritella ocoyana*, by W. P. Woodring. *Proceedings of Cordilleran section of the Geological Society of America*.
- Ecology of the mollusks of the Bowden formation, Jamaica, by W. P. Woodring. *Proceedings of Cordilleran section of the Geological Society of America*.
- Variations in Appalachian stratigraphy, by Charles Butts. Address as retiring president of the Geological Society of Washington; published in the bulletin of the society.
- Some results of recent work in the southern Taconic area, by E. B. Knopf. *American Journal of Science*.
- Structural symmetry in North America, by Arthur Keith. Presidential address at the Cleveland meeting of the Geological Society of America; published in the bulletin of the society.
- Structure contour maps of the Pittsburgh-Huntington Basin, by G. B. Richardson. *Bulletin of the Geological Society of America*.
- Our petroleum supply, by C. E. Dobbin. Presented at joint meeting of the Washington Society of Mechanical Engineers and the Washington Society of Engineers; published in the *Journal of the American Society of Mechanical Engineers*.
- The economic geology of coal in North America, by C. E. Dobbin. For volume on North America in *Geologie der Erde*.
- The carbon ratio theory in the light of Hilt's law, by Frank Reeves. *Bulletin of the American Association of Petroleum Geologists*.
- Major marine transgressions and regressions and structural features of the Gulf Coastal Plain, by L. W. Stephenson. *American Journal of Science*.

Correlation of the Upper Cretaceous or Gulf series of the Gulf Coastal Plain, by L. W. Stephenson. *American Journal of Science*.

Structural features of the Atlantic and Gulf Coastal Plain, by L. W. Stephenson. *Bulletin of the Geological Society of America*.

Cenozoic formations of the Coastal Plain east of the Mississippi River, by C. W. Cooke. For volume on North America in *Geologie der Erde*.

Correlation of the Cenozoic deposits of the eastern Gulf States, by C. W. Cooke. Presented at the meeting of the American Association for the Advancement of Science.

Sedimentary analcite, by C. S. Ross. *American Mineralogist*.

Titaniferous biotite, by C. S. Ross. *American Mineralogist*.

Anauxite, by C. S. Ross and W. F. Foshag. *American Mineralogist*.

Clay minerals and their methods of study, by C. S. Ross. *Proceedings of the International Soil Congress*.

Altered volcanic materials of the Paleozoic and their recognition, by C. S. Ross. *Bulletin of the American Association of Petroleum Geologists*.

The origin of the albitite bodies, by E. S. Larsen. Presented at the meeting of the Geological Society of America in Cleveland; published in the bulletin of the society.

Usefulness of petrology in the selection of limestone, by G. F. Loughlin. *Rock Products*.

Bibliography of building stone and resistance of natural stone to fire, by G. F. Loughlin. Presented at Atlantic City meeting of the American Society of Testing Materials.

Usefulness of petrology in quarrying and use of stone, by G. F. Loughlin. Presented at the meeting of the American Institute of Mining and Metallurgical Engineers.

American potash, by G. R. Mansfield. *Technical Engineering News*.

Geographic terminology, by M. R. Campbell. *Annals of Association of American Geographers*.

Correction for well logs, by W. B. Lang. *Bulletin of the American Association of Petroleum Geologists*.

The fracturing of incompetent beds, by T. S. Lovering. *Journal of Geology*.

Physico-chemical factors controlling magmatic differentiation and vein formation, by C. S. Ross. *Economic Geology*.

Dolomitization and ore deposition, by D. F. Hewett. *Economic Geology*.

The effect of gravitational compaction on the structure of sedimentary rocks, by W. W. Rubey. *Bulletin of the American Association of Petroleum Geologists*.

Gullies of the Great Plains formed by subsidence, by W. W. Rubey.

The compressibility of sand-mica mixtures [discussion], by W. W. Rubey. *Proceedings of the American Society of Civil Engineers*.

Some factors in rock metamorphism, by David White. *Proceedings of the National Academy of Sciences*.

A spiral graph of geologic time, by David White. *Journal of the Washington Academy of Sciences*.

A recent collection of late Pliocene invertebrates from the headwaters of the Amazon, by J. A. Gardner. *Journal of the Washington Academy of Sciences*.

Incompleted projects comprise studies of the copper deposits of the southern Appalachian region, by C. S. Ross and M. N. Short, a summary of which was issued as Press Memorandum 23711; a report on Appalachian oil-field studies, by G. B. Richardson; a review of the metal production of Europe, by D. F. Hewett; a report on gold reserves for the International Geological Congress, by G. F. Loughlin; studies of the Cambrian faunas of the upper Mississippi Valley, by E. O. Ulrich in cooperation with the Milwaukee Public Museum; studies of the Cretaceous formations of the Western Interior province, by J. B. Reeside, jr.; studies of the genus *Lingulidiscina*, the Devonian-Carboniferous faunas, the occurrence of *Archimedes* in the Pennsylvanian, and the genus *Myalina*, and revision of the paper on the genus *Astartella*, by G. H. Girty; study of the genus *Bairdia* and of conodont genera and species and papers on *Kirkbya* and *Parapar-*

chites, by P. V. Roundy; studies of the Eocene Foraminifera of the Coastal Plain, by J. A. Cushman; report on *Virgiana* in the Silurian of western North America, by Edwin Kirk; and research on microchemical methods of ore identification and on certain rare nickel ores, by M. N. Short.

ALABAMA

Investigations of iron-ore deposits in Colbert and Franklin Counties and at Florence, Lauderdale County, and Giles, Madison County, were conducted by E. F. Burchard in connection with a report on iron-ore reserves and production of the Tennessee River Basin in Alabama, Georgia, Kentucky, Tennessee, and Virginia, which was made and transmitted to the district engineer, Corps of Engineers, Florence, Ala. Mr. Burchard prepared a discussion of a paper on Occurrence and Age of Certain Brown Iron Ore Deposits in Alabama and adjacent States for Economic Geology. A report on the Bessemer and Vandalover quadrangles, Alabama, by Charles Butts, was issued as Geologic Folio 221.

ARIZONA

Examinations of the Supai formation of the Grand Canyon, Ariz., in a successful search for fossil evidence on which to determine the geologic age of the formation was made by David White. Paleontologic material was also procured from the Redwall and Cambrian formations and from the Unkar series. The field and travel expenses of this work were covered by the cooperation of the Carnegie Institution with a committee of the National Academy of Sciences in the investigation of the geologic history of the Grand Canyon section. Mr. White also made a partly successful search for fossil remains in the pre-Cambrian Mescal limestone, which was examined in several areas of central and northern Arizona, and continued office studies of the Permian fossil plants from the Hermit shale in the Grand Canyon. The following articles by Mr. White were published: The Flora of the Hermit Shale in the Grand Canyon, Arizona (Nat. Acad. Sci. Proc., vol. 13, No. 8, August, 1927); and Study of the Fossil Floras in the Grand Canyon, Arizona (Carnegie Inst. Yearbook No. 26, 1926-27, pp. 366-369). The Grand Canyon of the Colorado River, a text describing the geologic features, with a brief summary of the history, discovery, and exploration of the Grand Canyon, to be printed on the back of the revised topographic map of the Bright Angel quadrangle, was prepared by F. E. Matthes, who also wrote an article on Breaking a Trail Through Bright Angel Canyon, for Nature Notes, published by the National Park Service. Continued work on the construction of a relief model of the Grand Canyon, which is being done in cooperation with the National Park Service, American Museum Association, a National Academy committee, and the National Research Council, was supervised by Mr. Matthes. N. H. Darton prepared a paper on tectonics in Arizona and New Mexico for the meeting of the Geological Society of America in Cleveland. In connection with studies in southern San Juan County, Utah, A. A. Baker, H. E. Gregory, and J. B. Reeside, jr., made a reconnaissance of the geology of portions of north-eastern Arizona.

ARKANSAS

In informal cooperation with the Arkansas Geological Survey unpublished material has been contributed by the Federal Survey toward the compilation of a revised geologic map of Arkansas, which will be published by the State organization. A proposed addition to the Ouachita National Forest lying in Garland, Montgomery, and Hot Springs Counties, in west-central Arkansas, was the subject of a report by H. D. Miser to the Forest Service in connection with the preservation of the navigation of the streams in whose drainage basins the tract lies. A paper on the age relations of Carboniferous rocks of the Ouachita Mountains, Arkansas and Oklahoma, by H. D. Miser and C. W. Honess, was published as Bulletin 44 of the Oklahoma Geological Survey. The lead and zinc deposits of northern Arkansas are being studied by E. T. McKnight, in cooperation with the Arkansas Geological Survey. The faunas of the basal Fayetteville shale and the Morrow formation are the subject of papers in preparation by G. H. Girty. E. O. Ulrich studied the Paleozoic stratigraphy of Arkansas, accompanied by the State geologists of Arkansas and Missouri.

CALIFORNIA

A field study of the geology of the eastern part of the Santa Monica Mountains, Calif., was completed by H. W. Hoots, and a report on this study was submitted. A paper entitled "The Santa Monica Mountains, a Major Anticlinal Uplift Adjoining Los Angeles Basin," was presented by Mr. Hoots at a meeting of the American Association of Petroleum Geologists held in San Francisco in March. The results of his study of portions of Humboldt County were issued in the form of a press notice, Oil and Gas Exploration in Southwest Humboldt County. Further field work in the Elk Hills oil field was done by W. P. Woodring, and office work on the report was continued by Mr. Woodring and P. V. Roundy. Field study of the Plumas County copper deposits was begun by Adolph Knopf. In connection with his resurvey of the Mother Lode district Mr. Knopf studied new developments at many of the mines and completed the manuscript for a professional paper on the geology and ore deposits of the district. Office work on a report on the Allegheny district was continued by H. G. Ferguson, and work on a report on the geology of the Ivanpah quadrangle, which lies partly in Nevada, was continued by D. F. Hewett. A chapter on rocks of the Yosemite Valley was prepared by F. E. Matthes for the forthcoming professional paper on the valley, and the chapter on bedrock geology is being revised by F. C. Calkins. A paper on evidence of three glaciations of the Yosemite region was prepared by Mr. Matthes for the Geological Society of America. As a part of his study of the physiography of the upper San Joaquin Basin Mr. Matthes made a field reconnaissance in the upper drainage basin of the San Joaquin River. The report on the San Joaquin Basin is well advanced. A paper on late Tertiary thrust faults of the Mohave Desert by D. F. Hewett was submitted for publication in the Proceedings of the National Academy of Sciences. A paper on two Tertiary epochs of thrust faulting in the Mohave Desert was presented by Mr. Hewett at the annual meeting of the Geological Society of America. A report on nitrate deposits in southeastern California, with notes on deposits in southeastern Arizona and southwestern New Mexico, was completed by L. F. Noble. The San Andreas rift is being studied by Mr. Noble. The fault scarp near Bakersfield is described by G. K. Gilbert in Professional Paper 153. The Lassen Volcano Observatory, one of the stations maintained for studies of volcanology, has been conducted by R. H. Finch. A paper on the observatory was presented by Mr. Finch at a meeting of the Seismological Society of America at San Francisco in March. Mr. Finch made an investigation to determine the cause of the destructive mud flows of Mud Creek on Mount Shasta in 1924 and 1926. T. W. Stanton reported on Jurassic fossils from the Monte de Oro formation near Oroville.

COLORADO

Cooperative work by the Colorado Metal Mining Fund and the United States Geological Survey, in a study of the mining geology of the State, was continued under the general direction of G. F. Loughlin and B. S. Butler. The work consisted of a resurvey of old districts that needed checking in the light of new developments, detailed studies of districts which had not been previously mapped by the Geological Survey, and a general inspection of the metalliferous regions of the State. At Cripple Creek a study of the deeper mine workings was made by Mr. Loughlin, assisted for a short time by T. S. Lovering, and the preliminary results of this study were published as Technical Publication 13 of the American Institute of Mining and Metallurgical Engineers, entitled "Ore at Deep Levels in the Cripple Creek District." A restudy of the Creede district was made by E. S. Larsen, who will prepare a supplementary report. Work in the Ouray-Telluride area was started by W. S. Burbank and in the Breckenridge district by Mr. Lovering. New work included detailed studies in the Bonanza district, by Mr. Burbank; in the mineralized portion of the Montezuma quadrangle, by Mr. Lovering, who also made a reconnaissance of adjacent parts of the Fraser quadrangle and other bordering areas; and in the Alma district, by Mr. Butler and J. T. Singewald. A paper on the geology of the Moffat tunnel was presented at the meeting of the American Institute of Mining and Metallurgical Engineers by Mr. Lovering, who also gave a paper on the Williams thrust fault at the meeting of the Geological Society of America. Mr. Butler inspected the metalliferous region of the State to determine what kinds of study are needed and to select different places for future study. M. N. Short continued his studies of the ores from the several districts, and J. B. Reeside, Jr.

and Edwin Kirk studied and reported on Cretaceous and Ordovician invertebrates for Messrs. Lovering and Burbank. A report on the geology and ore deposits of the Leadville mining district, by S. F. Emmons, J. D. Irving, and G. F. Loughlin, was issued as Professional Paper 148. Studies of oil shales from the Green River formation of Colorado, Utah, and Wyoming were continued by W. H. Bradley, and three papers embodying the results of these studies have been completed for Geological Survey publication—one on the origin and microfossils of these shales, one on the varves and climate of the Green River epoch, and one on the occurrence and origin of analcite and meerschaum beds in the Green River formation. Mr. Bradley sent to Science a paper on zeolite beds in the Green River formation. Additional field work in the Book Cliffs coal fields was done by C. E. Erdmann, and progress was made on the report. Fresh-water shells from the Mesaverde of the eastern Book Cliffs were studied by Mr. Reeside. A paper describing ammonites from the Greenhorn limestone of Colorado is in preparation by Mr. Reeside, who also completed a paper on five new species of Cretaceous mollusks from Colorado and Utah for publication in the Journal of the Washington Academy of Sciences. Progress was made by M. R. Campbell on his report on the coal resources, structure, and stratigraphy of the eastern Yampa coal field. Data on the invertebrate fossils and stratigraphy were prepared by Mr. Reeside. Revision of the report by E. T. Hancock and J. B. Eby on the geology and coal resources of the Meeker quadrangle, Moffat and Rio Blanco Counties, was completed. Fluorspar deposits in Boulder County were examined by E. F. Burchard. A report on the correlation of geologic formations between east-central Colorado, central Wyoming, and southern Montana, by W. T. Lee, and one on the cephalopods of the Eagle sandstone and related formations in the Western Interior of the United States, by J. B. Reeside, jr., were issued as Professional Papers 149 and 151, respectively. A report on the geology and oil and gas prospects of northeastern Colorado, by K. F. Mather, James Gilluly, and R. G. Lusk, was issued as Bulletin 796-B.

DISTRICT OF COLUMBIA

Arthur Keith examined excavations in Washington in connection with his studies of the geology of the District of Columbia.

FLORIDA

The revised report and geologic map of Florida, which was prepared in cooperation with the Florida Geological Survey, was completed by C. W. Cooke with the assistance of W. C. Mansfield in the collection and determination of fossils. The report will be issued by the Florida Geological Survey. The mollusks of the Choctawhatchee marl, from the northwestern part of the State, are receiving monographic treatment by W. C. Mansfield. This is a cooperative project, and the report will be issued by the Florida Geological Survey. A paper entitled "Stratigraphy and Age of the Pleistocene Deposits in Florida from Which Human Bones Have Been Reported" was prepared by C. W. Cooke for publication in the Journal of the Washington Academy of Sciences. Part V of the report on the molluscan fauna of the Alum Bluff group of Florida, covering Tellinacea, Solenacea, Mactracea, Myacea, and Molluscoidea, by Julia Gardner, was published as Professional Paper 142-E.

GEORGIA

Iron ores of the Georgia portion of the Tennessee River Basin were examined by E. F. Burchard for a report to the Corps of Engineers, War Department. The State geologist consulted regarding the structure of the Tate marble belt with Arthur Keith, who reviewed maps and sections for the report by W. S. Bayley on this region.

HAWAII

From the headquarters of the section of volcanology, T. A. Jaggar, jr., in charge, at Volcano House, Hawaii, observations of the volcanic phenomena in the island group were continued, and in cooperation with the Hawaiian Volcano Research Association four seismograph stations were maintained on the island of Hawaii, and the publication of the Volcano Letter, a weekly leaflet

about the activities of the Hawaiian volcanoes, and the monthly Bulletin, containing the scientific results obtained at the station, was continued. Cooperation was maintained with the Coast and Geodetic Survey in running precise-level lines to the top of Mauna Loa, establishing a new tide-gage station at Hilo, and making gravity measurements at Hilo, Kilauea, and Mauna Loa. Mr. Jaggard gave a lecture on volcano research of the Geological Survey at a meeting of the Geophysical Union on April 27.

IDAHO

As a part of a comprehensive study of the ore deposits of south-central Idaho, C. P. Ross made investigations in the Casto quadrangle, completed a report thereon, and began field mapping of the Bayhorse quadrangle. The Thunder Mountain district of Idaho County is the subject of a special report by Mr. Ross which is about completed. Mr. Ross also prepared a paper on Mesozoic and Tertiary granitic rocks in Idaho for publication in the *Journal of Geology*. A report describing the geology, geography, and mineral resources of a portion of southeastern Idaho, by G. R. Mansfield, with descriptions of Carboniferous and Triassic fossils, by G. H. Girty, has been issued as Professional Paper 152. Mr. Mansfield has extended these investigations to cover the Paradise Valley, Ammon, and Portneuf quadrangles. The report on the Portneuf quadrangle has been completed and will be issued as Bulletin 803. Reports on the Paradise Valley and Ammon quadrangles are under way. Papers summarizing some of these investigations were presented by Mr. Mansfield at the annual meetings of the American Association for the Advancement of Science and the Geological Society of America, and a paper on the Idaho phosphate field was presented by Mr. Mansfield at the February meeting of the American Institute of Mining and Metallurgical Engineers in New York. A preliminary report on the Pend Oreille district, prepared by Edward Sampson in cooperation with the Idaho Bureau of Mines and Geology, has been transmitted to that bureau for publication. A paper on stages in the contact metamorphism in the Pend Oreille district was presented by J. L. Gillson before the Mineralogical Society of America at Cleveland. A paper on lake beds in Idaho as building stones has been submitted for publication by C. H. Behre. Fossil collections sent in by the Idaho Bureau of Mines and Geology were studied and reported on by the paleontologists of the United States Geological Survey as a part of the informal cooperation which exists between the two organizations—Lower Cretaceous invertebrates by T. W. Stanton, Devonian invertebrates by Edwin Kirk, fossil plants by E. W. Berry, Carboniferous fossils by G. H. Girty and P. V. Roundy, and fresh-water mollusks collected near Payette by W. C. Mansfield. W. C. Alden carried on reconnaissance mapping in Fremont County in connection with his general studies of the glacial geology and physiography of the northwestern part of the United States. A report on a Pleistocene manganese deposit in Bannock County, by D. F. Hewett, was issued as Bulletin 795-H.

ILLINOIS

Progress was made toward the completion of a geologic folio on the Equality and Shawneetown quadrangles, which lie partly in Illinois and partly in Kentucky. The investigation has been made by Charles Butts in cooperation with the Illinois Geological Survey. Outcrop material from Illinois was studied by P. V. Roundy in connection with his general studies in micropaleontology. M. R. Campbell conferred with the Illinois State geologist and his associates regarding the character, classification, and use of Illinois coals in connection with his general study of the classification of coal. W. C. Alden, in company with M. M. Leighton, State geologist, made a brief field study of the glacial and interglacial deposits in the State. A paper on some issues in Chester stratigraphy in western Kentucky and southern Illinois by Charles Butts was sent to the *Journal of Geology*. Work on the genesis of ores is mentioned under Missouri.

INDIANA

Study of a new crinoid genus from the Devonian of Indiana was begun by Edwin Kirk. Carboniferous invertebrates and gastropods from the Spargen limestone were studied by P. V. Roundy. The manuscript of a report on the grading of Indiana limestone, by G. F. Loughlin, has been completed.

IOWA

M. R. Campbell conferred with the Iowa State geologist and his associates regarding the character, classification, and use of Iowa coal, in connection with his general study of the classification of coal.

KANSAS

A cooperative report on the geology of Cowley County, Kans., with special reference to the occurrence of oil and gas, was completed by N. W. Bass and transmitted to the Kansas Geological Survey for publication. T. W. Stanton reported on Comanche ammonites; G. H. Girty and P. V. Roundy studied the Carboniferous invertebrates, and Mr. Roundy examined Carboniferous microfossils in connection with his general studies of micropaleontology.

KENTUCKY

Progress was made by Charles Butts toward the completion of a geologic folio on the Equality and Shawneetown quadrangles, which lie partly in Kentucky. A report on iron-ore reserves of the Tennessee River Basin was made by E. F. Burchard to the Corps of Engineers, War Department. A paper on some issues in Chester stratigraphy in western Kentucky and southern Illinois was prepared by Mr. Butts for publication in the *Journal of Geology*.

LOUISIANA

The formations of the Claiborne group in Louisiana and Texas were correlated by Julia Gardner. Reports on Comanche fossils from drill cores of deep wells in Louisiana were made by T. W. Stanton. Carboniferous invertebrates from Louisiana were studied by P. V. Roundy.

MAINE

Preparation of a geologic folio describing the Portland and Casco Bay quadrangles, Maine, was continued by Laurence LaForge. Arthur Keith made geologic examinations in the field and conducted office investigations to determine the cause of recent earthquakes which have been felt in Maine. He prepared a paper on the earthquake at Milo, Me., for presentation at the meeting of the Seismological Society at Charlottesville, Va., in May, 1928.

MARYLAND

In connection with his cooperative glacial studies in Pennsylvania Frank Leverett examined the gravel deposits of Susquehanna River of Illinoian age, in Maryland. He was accompanied by C. W. Cooke and Mrs. E. B. Knopf in a correlation of the terraces near the mouth of the Susquehanna. G. W. Stose began field work in the South Mountain region of the Emmitsburg and Ijamsville quadrangles, the results of which will probably be published as a folio. The Frederick County report which A. I. Jonas is preparing for the Maryland Geological Survey, in informal cooperation with the United States Geological Survey, will contain contributions by Mr. Stose on the South Mountain region. E. W. Berry made a contribution to a short paper on the coal fields of Maryland which the Bureau of Mines requested the Geological Survey to prepare for inclusion in a report of that bureau. Notes on Pleistocene faunas from Maryland and Virginia, by W. C. Mansfield, were included in Professional Paper 150-F, published during the year.

MASSACHUSETTS

Further field studies in the Taconic area, including the Greylock and Berlin quadrangles, Massachusetts, were made by L. M. Prindle, and progress was made toward the completion of the report covering this area.

MICHIGAN

Studies of the Carboniferous invertebrate fauna of the Marshall sandstone were continued by G. H. Girty. In continuation of his studies of the Paleozoic of Michigan, E. O. Ulrich made a field examination of the section to the east and west of Escanaba and of a section on or near the south shore of Lake Superior, in informal cooperation with the Michigan Geological Survey. Proof of the professional paper on the copper deposits of Michigan, by B. S. Butler and W. S. Burbank, has been reviewed.

MINNESOTA

The manuscript of a report on the Quaternary geology of Minnesota and parts of adjacent States was completed by Frank Leverett, assisted by F. W. Sardeson. This report has been prepared in cooperation with the Minnesota Geological Survey and will be issued as a professional paper of the United States Geological Survey.

MISSOURI

For the studies of the genesis of zinc ores in the Central States which C. E. Siebenthal and R. C. Wells are making, Mr. Siebenthal collected specimens from southeastern Missouri and southern Illinois.

MONTANA

Investigations of the metalliferous deposits in the vicinity of Helena, Mont., were continued by J. T. Pardee, and a preliminary report on the gold deposits at York, Lewis and Clark County, was issued as Press Memorandum 2323. At the request of the Post Office Department, Mr. Pardee examined deposits of the Vermiculite & Asbestos Co., Libby, Mont., and prepared a report concerning them. A paper entitled "Deposits of Vermiculite and Other Minerals in the Rainy Creek District Near Libby, Mont.," by Mr. Pardee and E. S. Larsen, jr., has been submitted for publication in Contributions to Economic Geology, and a paper on the stocks of the alkaline rocks in Rainy Creek near Libby, by the same authors, for publication in the Journal of Geology. Mr. Pardee continued work on a report on late Tertiary faults in southwestern Montana and prepared a report on the geology of a dam site in Hungry Horse Canyon, on the South Fork of Flathead River, for the Columbia Basin Irrigation League. Physiographic and glacial studies in western Montana and office work on the report on the geology and physiography of that region were continued by W. C. Alden. Studies of coal fields of southern and east-central Montana were carried on by two parties, one under the direction of A. J. Collier, assisted by C. E. Erdmann, who continued mapping the coal fields of McCone County, and another under the supervision of N. W. Bass, who mapped the Ashland coal field of Powder River County and adjacent parts of Rosebud and Custer Counties. In the office Mr. Collier made some progress on his report on the geology of the Little Rocky Mountains and Fort Belknap Indian Reservation. The report on the Bearpaw Mountains was revised by Frank Reeves, who also has in hand a report on the geology of the Big Snowy Mountains. A report on the geology and mineral resources of parts of Carbon, Big Horn, Yellowstone, and Stillwater Counties, by R. S. Knappen and G. F. Moulton, was completed. J. B. Reeside, jr., identified Jurassic fossils for Frank Reeves and studied and reported on Lance invertebrates for A. J. Collier. Cretaceous invertebrates were reported on by T. W. Stanton, and Carboniferous invertebrates were studied by G. H. Girty. Reports on the correlation of geologic formations between east-central Colorado, central Wyoming, and southern Montana, by W. T. Lee, and on the cephalopods of the Eagle sandstone and related formations in the Western Interior of the United States, by J. B. Reeside, jr., were issued as Professional Papers 149 and 151, respectively. A report on the phosphate rock in the Three Forks-Yellowstone Park region, Montana, by D. D. Condit, E. H. Finch, and J. T. Pardee, was issued as Bulletin 795-C.

NEVADA

The final report on the Pioche district, Nevada, which includes the Highland, Bristol Range, and Panaca quadrangles, was completed by L. G. Westgate and Adolph Knopf, Mr. Westgate describing the general geology of the area and

Mr. Knopf the geology of the ore deposits and the mines. Edwin Kirk discussed Ordovician, Silurian, and Devonian invertebrates for this report. A bulletin on the geology and ore deposits of the Goodsprings quadrangle has been completed by D. F. Hewett. A report on the areal and economic geology of the Hawthorne and Tonopah quadrangles is in preparation by H. G. Ferguson, and a report on the mining districts in the Carson Sink region by F. C. Schrader is nearing completion. A study of the Lowry Peak quadrangle was begun by Mr. Ferguson, who examined some of the mines in the Eureka district and with Messrs. Girty, Kirk, and Longwell studied the stratigraphy of the region. Notes on the stratigraphy and structure of the northwestern portion of the Spring Mountains and a paper on a late Paleozoic positive area in Nevada were submitted by T. B. Nolan for publication in the American Journal of Science. Geologic field studies in the Las Vegas quadrangle were continued by C. R. Longwell, and general geologic studies in the Frenchman Flat Basin, Las Vegas and Furnace Creek quadrangles, and the Opal Mountain Basin, Camp Mohave quadrangle, by C. E. Erdmann. Ordovician, Silurian, and Devonian fossils were determined by Mr. Kirk for Messrs. Longwell and Erdmann. A "Tectonic Study of Some Basin Ranges in Nevada" was submitted by Mr. Longwell for outside publication. Mr. Hewett prepared a summary of the stratigraphy and structure of the Great Basin area for publication in the volume on North American geology to be included in "Geologie der Erde." Reports on the quicksilver deposits of the Pilot Mountains, by W. F. Foshag, and the Gilbert district, by H. G. Ferguson, were issued as Bulletins 795-E and 795-F, and a description of the Chalk Mountain, Quartz Mountain, Gold Basin, and King mining districts was issued as a press memorandum.

NEW HAMPSHIRE

In connection with his studies of the causes of recent earthquakes in the northeastern United States, Arthur Keith made some field investigations in New Hampshire and collected data from various sources.

NEW JERSEY

A paper on the results of field study in 1927 of the glacial and associated deposits of Pennsylvania and New Jersey was presented by Frank Leverett at the meeting of the Geological Society of America in Cleveland December 28-31. Field work to determine the age of the Rancocas and Manasquan formations of New Jersey was done by L. W. Stephenson and C. W. Cooke, and a paper entitled "The Eocene Age of the Supposed Late Upper Cretaceous Fauna of New Jersey," setting forth the results of this work, was prepared by them for publication in Science.

NEW MEXICO

The investigations in search of potash were continued in New Mexico, and a temporary building was erected on the post-office grounds at Roswell to store the well cores and to serve as a laboratory. The core of well 3, in Eddy County, the drilling of which was completed by the Bureau of Mines, was sampled and studied by W. B. Lang and J. W. Vanderwilt, and selected portions were sent to Washington for analysis. Samples of a core from a private potash test in Eddy County and many samples of well cuttings from Eddy, Lea, and adjacent counties have been studied. Three press notices entitled "Government Strikes Potash in New Mexico," "Potash Found in 26 More Wells in Texas and New Mexico," and "Potash Exploration—Third Government Test Strikes Substantial Bodies of Potash" were prepared by G. R. Mansfield. For a study of the ore deposits of Socorro County being made by the New Mexico Bureau of Mines and Mineral Resources the United States Geological Survey will supply data on the Magdalena mining district, compiled by G. F. Loughlin, and bring up to date a report begun some years ago on the Santa Rita mining district by A. C. Spencer. Upper Cretaceous invertebrates from the Santa Rita district were identified by T. W. Stanton. Mr. Spencer made a brief visit to a tin-bearing district in Sierra County. N. H. Darton began the preparation of a chapter on New Mexico for inclusion in the volume on the geology of North America for publication in "Geologie der Erde." The preparation of a report on Lake Valley invertebrates was continued by G. H. Girty. Field work in the San Juan Basin of northwestern New Mexico was begun by C. H. Dane and J. B. Reeside, jr., who carried on stratigraphic studies and detailed plane-table

mapping of the coal-bearing and associated formations, primarily for the purpose of land classification. A brief stratigraphic reconnaissance of north-western New Mexico was made by A. A. Baker, with H. E. Gregory and J. B. Reeside, jr., in connection with Mr. Baker's work in southern Utah. Mapping of the Santa Clara quadrangle was begun by E. S. Larsen, with C. S. Ross, in connection with the report on the igneous geology of the Jemez Mountains. A report on the cephalopods of the Eagle sandstone and related formations in the Western Interior of the United States, by J. B. Reeside, jr., was published as Professional Paper 151, and a report on the geology and ore deposits of the Mogollon mining district, by H. G. Ferguson, as Bulletin 787. Investigations of tectonics are mentioned under Arizona.

NEW YORK

In connection with studies of the southern Taconic area Mrs. E. B. Knopf made a special investigation of the structural relations of the pre-Cambrian and Paleozoic rocks in the Poughkeepsie and Clove quadrangles, New York, and continued work on a report on these investigations. Study of the geology of the Hoosick and Berlin quadrangles was continued by L. M. Prindle in his investigation of the Taconic region of New York, Vermont, and Massachusetts. Granite intrusions in the vicinity of Lake Placid, in the Adirondacks, were examined by James Gilluly.

NORTH CAROLINA

A paper on seven new species and five new subspecies of mollusks from the Miocene of Virginia and North Carolina, with a brief outline of the divisions of the Chesapeake, was prepared by W. C. Mansfield for publication in the Proceedings of the United States National Museum. Mr. Mansfield made additional field investigations in connection with his studies of the upper Miocene of the Carolinas. An article on the origin of nickel silicates at Webster, N. C., was written by C. S. Ross, E. V. Shannon, and F. A. Gonyer for Economic Geology. Notes on Pliocene and Pleistocene faunas from North Carolina, by W. C. Mansfield, were included in Professional Paper 150-F, issued during the year.

NORTH DAKOTA

Cuttings from the Glenfield well, eastern North Dakota, were studied by J. B. Reeside, jr. The report on the geology and lignite resources of the Marmarth field, southwestern North Dakota, by C. J. Hares, is in press and will be issued as Bulletin 775. Studies of stratigraphy of the Fox Hills and Lance formations are mentioned under South Dakota.

OHIO

The manuscript of the Cleveland geologic folio, describing in detail the geology and mineral resources of the Cleveland, Berea, and Euclid quadrangles, has been completed. Work on a paper on the Waverly fauna was continued by G. H. Girty. Data on mild earth tremors in Ohio and other Eastern States are being gathered by Arthur Keith in libraries and newspapers. Carboniferous microfossils from Ohio were examined by P. V. Roundy.

OKLAHOMA

Office work on a report covering the richest portion of the zinc-lead ore district of the Joplin region of Missouri, Kansas, and Oklahoma was continued by C. E. Siebenthal. A paper on the age relations of the Carboniferous rocks of the Ouachita Mountains, by H. D. Miser and C. W. Honess, was completed by Mr. Miser and transmitted to the Oklahoma Geological Survey, which published it as Bulletin 44. Papers on fossiliferous boulders in the Ouachita "Caney" shale and the age of the shale containing them, and on the Paleozoic section of the Arbuckle and Wichita uplifts, by E. O. Ulrich, have been submitted to the Oklahoma Geological Survey for publication. Descriptions of the faunas of the Moorefield shale and the Morrow and Glenn formations were continued by G. H. Girty, who also worked on a paper on an uncommon Penn-

sylvania fauna from Oklahoma. Microfossils from the Caney and Moorefield shales were studied by P. V. Roundy. Mr. Roundy attended sales of Osage leases at Pawhuska December 12 and March 28 and 29, to advise the Office of Indian Affairs concerning the adequacy of bids. T. W. Stanton reported on Comanche ammonites from Oklahoma.

OREGON

The manuscript for a revised report on the Wallowa Mountains, Oreg., was completed by C. P. Ross. A paper on zeolites from Ritter Hot Springs, Grant County, was completed by D. F. Hewett, E. V. Shannon, and F. A. Gonyer for publication in the American Journal of Science. The structure of the Klamath Lake region is described by G. K. Gilbert in Professional Paper 153.

PENNSYLVANIA

Cooperative studies of glacial geology in Pennsylvania were continued by Frank Leverett. Two reports covering this investigation will be submitted to the Pennsylvania Geological Survey for publication—one on the pre-Wisconsin drifts of the Susquehanna drainage basin, which is about completed, and another on pre-Wisconsin drifts of the Lehigh, Delaware, and Raritan drainage basins. Other cooperative projects that are under way include reports on the Lancaster quadrangle and on the York, Middletown, Hanover, and New Cumberland quadrangles by G. W. Stose and A. I. Jonas, Miss Jonas working for the Pennsylvania Survey. Mr. Stose contributed material and time to the revision of the Pennsylvania geologic map, which is being compiled by the State survey. Progress was made on reports on the New Kensington, Butler, and Zellenople quadrangles by G. B. Richardson; on the Quakertown-Doylestown geologic folio by Mr. Stose and Florence Bascom; and on a report on the Tyrone quadrangle by Charles Butts. A paper on the Martinsburg shale and lava flow in Pennsylvania by Miss Jonas, one on the structure of the Pittsburgh-Huntington Basin by Mr. Richardson, and one on the high-level gravel on Susquehanna River by Mr. Stose were presented at the annual meeting of the Geological Society of America. G. H. Girty continued his studies of the Pottsville and other Carboniferous faunas of Pennsylvania. Devonian and Ordovician invertebrates were studied by E. O. Ulrich for the Pennsylvania survey. A description of the Pocono fauna of the Broad Top coal field by Mr. Girty was published as Professional Paper 150-E.

SOUTH CAROLINA

In connection with studies of the upper Miocene of the Carolinas, W. C. Mansfield made trips to South Carolina to examine these deposits in the field and collect material for office study.

SOUTH DAKOTA

A paper on the contact of the Fox Hills and Lance formations in the northern Great Plains, by C. E. Dobbin and J. B. Reeside, jr., was revised by the authors. E. W. Berry studied the flora of the Newcastle sandstone in the Black Hills. A report on the cephalopods of the Eagle sandstone and related formations in the Western Interior of the United States, by Mr. Reeside, was issued as Professional Paper 151.

TENNESSEE

Additional data were gathered by E. F. Burchard to bring up to date his report on brown iron ores of the western Highland Rim, a cooperative project with the Tennessee Geological Survey, and the revised manuscript was transmitted to the State for publication. Mr. Burchard prepared a report on iron-ore reserves of the Tennessee River Basin for the Corps of Engineers, War Department, and his report on the brown iron ores of west-middle Tennessee was issued as Bulletin 795-D. R. D. Mesler prepared Ozarkian and Canadian invertebrates collected by Charles Butts, and P. V. Roundy studied Carboniferous invertebrates. A trip to Jefferson City and Mascot to examine zinc mines with special reference to dolomitization was made by E. T. McKnight.

TEXAS

The potash investigations for the year were largely centered in Texas. Drilling of 5 wells, 1 in Ector County, 2 in Crockett County, and 2 in Upton County, was completed by the Bureau of Mines. Four of these wells were logged, studied, and sampled, and samples were sent to the Washington office for analysis. W. B. Lang and J. W. Vanderwilt, of the field force, and E. P. Henderson, of the Washington office, participated in this work. An important part of the work in Texas consisted in the selection of three drilling sites in Reagan, Glascock, and Crane Counties, which were recommended to the Bureau of Mines as a basis for its drilling program for the year. Two press notices entitled "First Government Potash Test Encouraging" and "Potash Struck by Four Government Tests in Texas" were prepared by G. R. Mansfield. Field mapping of the Upper Cretaceous formations of Texas was extended by L. W. Stephenson, who also continued office studies in connection with his report on the Upper Cretaceous formations of Texas. A paper entitled "Notes on the Taylor and Navarro Formations of Northeastern Texas," by L. W. Stephenson and C. H. Dane, was sent to the American Association of Petroleum Geologists for publication. Field and office studies of the stratigraphy and paleontology of the Eocene and later Tertiary formations of Texas were continued by Julia Gardner, who also continued studies of the Midway formations of the State in cooperation with the Texas Bureau of Economic Geology. Miss Gardner completed a short paper covering the Tertiary formations of the western Gulf region for publication in the volume on North America in *Geologie der Erde* and prepared a paper on Tertiary formations in Texas for the meeting of the American Association for the Advancement of Science. She had in preparation a paper setting forth general results of the reconnaissance made along the Wilcox-Clalborne contact in eastern Texas, of which W. C. Spooner and A. F. Crider are joint authors. Nitrate deposits at San Saba and in Brewster and Presidio Counties and prospects near Candelaria were examined by G. R. Mansfield. A reconnaissance of the part of western Texas along the Rio Grande and at points in Brewster County was made by T. W. Stanton in connection with his studies of the stratigraphy of the Cretaceous of Texas. Mr. Stanton also continued the study of the Comanche stratigraphy of Texas and cooperated with N. H. Darton, who is mapping the geology of central and western Texas, in reporting on Comanche collections. Outcrop material from the State and Carboniferous invertebrates and Cretaceous ostracodes for comparative generic references were studied by P. V. Roundy, and a collection of ammonites from the Eagle Ford formation of Texas by J. B. Reeside, jr. Studies of the salt-dome cap rock were continued by M. I. Goldman. The work of gathering and compiling data for the revised geologic map of Texas has been continued by Messrs. Stanton and Darton for the western and central parts of the State and by L. W. Stephenson and Miss Gardner for the Coastal Plain area.

UTAH

Field studies of the stratigraphy and structure of portions of southeastern Utah primarily to determine the oil possibilities of the region were continued. An area between the Green and Colorado Rivers in Grand County in the vicinity of Thompsons, a northward extension of the area mapped by E. T. McKnight in 1926, was mapped by a party in charge of Mr. McKnight and C. H. Dane, assisted by C. E. Erdmann and J. W. Vanderwilt for a portion of the time. Reports on these investigations are in progress. An area east of the Colorado in northern San Juan County, known as the Moab district, was mapped by A. A. Baker's party, working southward from the area mapped by him in 1926. A report on this work is in preparation. A preliminary report on these investigations in southeastern Utah, by C. E. Dobbin and J. B. Reeside, jr., was issued as Press Notice 16318, *Geology and Oil in Southeastern Utah*. A party in charge of Mr. Baker began areal and structural geologic mapping of an area in southwestern San Juan County, lying between the San Juan River on the north, the Navajo Indian Reservation on the east, the Colorado River to the west, and the Arizona boundary to the south. J. B. Reeside, jr., who is studying the Mesozoic stratigraphy of Utah, collaborated with Mr. Baker in field studies in this part of the State. Studies of oil shale by W. H. Bradley are mentioned under Colorado. D. J. Fisher continued the preparation of a report

on the Book Cliffs coal field. A paper by Messrs. Dobbin and Reeside on problems of the Chugwater-Sundance contact was submitted for publication by the American Association of Petroleum Geologists. A report on the geology and ore deposits of the Gold Hill quadrangle is in preparation by T. B. Nolan, who presented a paper on stratigraphy and structure of the quadrangle at the meeting of the Geological Society of America. A paper describing the areal geology, ore deposits, and stratigraphy of the Stockton and Fairfield quadrangles is in preparation by James Gilluly. Mr. Gilluly presented a paper on Basin Range faults in the Oquirrh Range at the annual meeting of the Geological Society of America. The general geology of the Cottonwood-American Fork district is being described by F. C. Calkins, the report on the ore deposits of this district having been completed by B. S. Butler. D. F. Hewett's work on the Great Basin area is mentioned under Nevada. A paper on the Upper Cretaceous section in the Colob Plateau, southwestern Utah, by G. B. Richardson, was sent to the Journal of the Washington Academy of Sciences. P. V. Roundy studied Carboniferous invertebrates. The structure of the Wasatch, Fish Springs, and House Ranges is described by G. K. Gilbert in Professional Paper 153, which was issued a few days after the end of the year. The following reports were issued during the year: A Section of the Kaibab Limestone in Kaibab Gulch, Utah, by L. F. Noble (Professional Paper 150-C); Sedimentary Rocks of the San Rafael Swell and Some Adjacent Areas in Eastern Utah, by James Gilluly and J. B. Reeside, jr. (Professional Paper 150-D); The Cephalopods of the Eagle Sandstone and Related Formations in the Western Interior of the United States, by J. B. Reeside, jr. (Professional Paper 151); Economic Geology of the Castlegate, Wellington, and Sunnyside Quadrangles, Carbon County, Utah, by F. R. Clark (Bulletin 793); Geology and Coal Resources of the Salina Canyon District, Sevier County, Utah, by E. M. Spieker and A. A. Baker (Bulletin 796-C); and Potash in Great Salt Lake Desert, Utah (Press Notice 16251).

VERMONT

Studies of a part of the Taconic area of southwestern Vermont, included in the Bennington quadrangle, were continued by L. M. Prindle. Stratigraphic and structural studies in northwestern Vermont were made by Arthur Keith.

VIRGINIA

Geologic studies in different parts of Virginia were made in cooperation with the Virginia Geological Survey, the most important one being investigations for the revision of a geologic map of Virginia, which will be issued by the State. Charles Butts continued mapping the Appalachian Valley portion, A. I. Jonas the Piedmont area, and W. C. Mansfield the Coastal Plain area. Contributions were also made by G. W. Stose, E. O. Ulrich, and M. I. Goldman. A cooperative study of the geology of the warm springs in the Shenandoah Valley and in the mountain valleys in Alleghany, Bath, and Highland Counties was made by Frank Reeves. Charles Butts accompanied Mr. Reeves for a study of the stratigraphy of this region. Iron-ore deposits at Rectortown, Covington, Clifton Forge, Barbours Creek, Bastian, and Rocky Gap were examined by E. F. Burchard, who conferred with owners of these deposits and with Virginia State officials. A report on the Great Gossan lead is in preparation by C. S. Ross. A manuscript on the geology and sand and gravel resources of the Coastal Plain of Virginia, by C. K. Wentworth, has been transmitted to the State for publication. Field and office work in connection with the preparation of a paper on new species of mollusks from the Miocene of Virginia was continued by W. C. Mansfield, and a paper entitled "Seven New Species and Five New Subspecies of Mollusks from the Miocene of Virginia and North Carolina, with a Brief Outline of the Divisions of the Chesapeake," will be published in the Proceedings of the United States National Museum. Deposits of manganese ore near Woodstock were examined by E. F. Burchard, D. F. Hewett, H. D. Miser, and M. I. Goldman to note new developments. Investigations of iron ores for the War Department are mentioned under Alabama. A paper on the Helderberg group of Virginia and West Virginia was submitted by F. M. Swartz for publication. Notes on Pleistocene faunas from Maryland and Virginia, by W. C. Mansfield, were included in Professional Paper 150-F.

WASHINGTON

Reservoir sites near Washtucna and Kahlotus, Wash., were examined by J. T. Pardee for the Columbia Basin Irrigation League. E. W. Berry continued work on a paper on the Puget flora left unfinished by the late F. H. Knowlton, and also on a paper on the Latah flora, much of the material for which was collected by Mr. Knowlton.

WEST VIRGINIA

The study of the Devonian and basal Mississippian rocks of Randolph County and portions of Pocahontas County, W. Va., for the purpose of gathering materials for use in the preparation of a report on the floras of the Devonian and lower Mississippian of this part of the State, was carried on by David White in cooperation with the West Virginia Geological Survey. In the office he studied the Devonian and lower Mississippian floras of West Virginia, including materials from other parts of the northern Appalachian trough. G. H. Girty studied Pottsville faunas of West Virginia. A paper on the Helderberg group of Virginia and West Virginia was submitted by F. M. Swartz for publication.

WISCONSIN

E. O. Ulrich devoted some time to the description of species of *Dikelocephalus* in connection with the preparation of a paper on the Upper Cambrian faunas of Wisconsin for publication by the Public Museum of Milwaukee. Manuscript for a geologic folio on the Sparta and Tomah quadrangles, by F. T. Thwaites, W. H. Twenhofel, and Lawrence Martin, has been completed by the authors and is being reviewed.

WYOMING

Parts of Lincoln County, W. Va., and Yellowstone Park were studied by W. C. Alden in the course of his physiographic and glacial investigations. A paper on the Gros Ventre landslide and flood was prepared by Mr. Alden for publication in the Transactions of the American Institute of Mining and Metallurgical Engineers, and one on the glaciation of Yellowstone National Park and its environs for publication in the Ranger-Naturalist Manual for 1928. At the request of N. C. Grover, chief of the water-resources branch, Mr. Alden also prepared notes on proposed dam sites west of the Wind River Mountains. The preparation of reports on the stratigraphy, structure, and oil and gas possibilities of the Black Hills rim was continued by W. W. Rubey, who completed a paper on lithologic studies of fine-grained Upper Cretaceous sedimentary rocks from the Black Hills region. Invertebrate fossils from the western Black Hills were identified by J. B. Reeside, jr. Field studies of oil-shale deposits in the Green River Basin were continued by W. H. Bradley. Other work on oil shale is mentioned under Colorado. A paper entitled "Problems of the Chugwater-Sundance Contact" was written by C. E. Dobbin and Mr. Reeside for publication in the Bulletin of the American Association of Petroleum Geologists. Mr. Reeside collaborated with R. R. Woolley, of the water-resources branch, in drawing geologic cross sections of dam sites on Green River, Colo., Utah, and Wyo., for a paper which Mr. Woolley is preparing. A paper on the contact of the Fox Hills and Lance formations in the northern Great Plains, by Messrs. Dobbin and Reeside, is being revised by the authors. T. W. Stanton reported on Lance and Fort Union invertebrates. Fossil plants from the Frontier formation of Wyoming were studied by E. W. Berry. A report on the iron-ore deposits in the Seminoe Mountains is in preparation by T. S. Lovering. The following reports were issued during the year: Correlation of Geologic Formations Between East-Central Colorado, Central Wyoming, and Southern Montana, by W. T. Lee (Professional Paper 149); Cephalopods from the Lower Part of the Cody Shale of Oregon Basin, Wyo., by J. B. Reeside, jr. (Professional Paper 150-A); The Cephalopods of the Eagle Sandstone and Related Formations in the Western Interior of the United States, by J. B. Reeside, jr. (Professional Paper 151); The Gillette Coal Field, Northeastern Wyoming, by C. E. Dobbin and V. H. Barnett, with a chapter on the Minturn district and the northwestern part of the Gillette field, by W. T. Thom, jr. (Bulletin 796-A); and Geology and Oil and Gas Possibilities of the Bell Springs District, Carbon County, Wyo., by C. E. Dobbin, H. W. Hoots, and C. H. Dane (Bulletin 796-D).

WORK IN CHEMISTRY

In connection with geologic or mineralogic studies 32 partial and 60 complete analyses, each of the latter consisting of 10 to 18 separate determinations, were made and 5,627 samples of potash salts were examined. Special examinations and tests were made of 71 specimens submitted in connection with specific problems. Specimens to the number of 2,055 sent by 1,077 persons not connected with the Geological Survey were identified. A number of these specimens proved to be of value to the scientific and economic work of the Geological Survey.

The study of analytical methods for lead, thorium, and uranium, with particular reference to the determination of the geologic age of radioactive minerals, was continued by R. C. Wells, in cooperation with the committee of the National Research Council on the measurement of geologic time by atomic disintegration. M. F. Connor cooperated as guest chemist of the Geological Survey laboratory. Mr. Wells also studied concentrates from granites and kolm from Sweden, whose age was definitely determined and which can be correlated with the Upper Cambrian by means of fossils. Mr. Wells did some further experimental work on the solubility of calcium carbonate in salt solutions, the conditions under which the mineral kernite forms, and the occurrence of selenium in sulphide ores and commercial sulphuric acid.

An intensive study of the properties and genetic relationships of potash and associated minerals from the Texas-New Mexico field was made by W. T. Schaller, who is now preparing a report on the mineralogy of these deposits. Mr. Schaller also studied in the field, supplemented by laboratory investigations, the borate minerals of the Kramer district of California, of which three proved to be new in science.

After extended laboratory experiments George Steiger prepared for publication a paper on the disintegration of Indiana limestone. For the committee on sedimentation of the National Research Council, Mr. Steiger prepared a bibliography on chemical work done during the year having a bearing on the subject of sedimentation.

A dehydration study of certain clays, showing changes in their optical properties as the water was driven out by heat or by the lowering of the vapor tension of the desiccating air, with the object of determining their chemical construction, was made by J. G. Fairchild in cooperation with C. S. Ross.

A study of the changes in optical properties of triplite due to the variation in chemical composition was made by E. P. Henderson.

Progress in the search for soluble potash salts was so satisfactory during the year that it can now be stated with reasonable assurance that there are in the salt fields of eastern New Mexico and western Texas deposits of these salts which compare favorably with and possibly when developed and their exact extent is known will even surpass the German and French deposits both in extent of the beds and in their potash content. Water has been an endless source of trouble and expense in the foreign mines, but no water has yet been encountered in the New Mexico-Texas salt formation, and the rich beds in general lie nearer to the surface here than abroad. These condi-

tions will give our domestic deposits a decided advantage when mining operations are begun.

During the year 4,743 cuttings taken from 55 wells drilled for oil and 884 samples from 13 core wells drilled in the search for potash were examined for their potash content. The cuttings came from wells drilled in the following counties:

Texas:

Crane
Midland
Glasscock
Upton
Crockett
Ector
Pecos
Reagan
Garza
Winkler
Loving

Texas—Continued.

Andrews
Ward
New Mexico:
Guadalupe
Lea
Eddy
De Baca
Quay
Chaves
Kansas:
Pratt

The area in which the most intensive core drilling was done lies in Eddy County, N. Mex. The American Potash Co. of New Mexico drilled its first core well about 20 miles northeast of Carlsbad, and the core was examined by the Geological Survey in 1927. This company's property is mainly on territory covered by the potash leasing act. During the fiscal year the Geological Survey has examined five additional cores from wells drilled within a radius of 6 miles from the original well. These cores appear to indicate several beds of sylvinite (potassium chloride and sodium chloride) and two or three beds of polyhalite (calcium-potassium-magnesium sulphate) ranging in thickness from 2 to 7 feet and carrying from 10 to 20 per cent of potash (K_2O). The cores from seven wells drilled under the appropriation made by Congress for investigating potash deposits were also examined. Three of these wells are in New Mexico—20 miles north, 10 miles northwest, and 12 miles south of the original American Potash Co.'s well. No beds of sylvinite were encountered in these wells, but numerous beds of polyhalite were found ranging in thickness from a few inches to 10 feet and having a potash content of 10 to 18 per cent. The Government drilled four wells in Texas, in southwestern Ector County, northwestern Crockett County, and southwestern and western Upton County. The salts encountered in these wells are very similar to those from the New Mexico wells, the only potash salt being polyhalite. In general the strata are not quite so thick nor so rich as those in the New Mexico wells, but they were closer to the surface. A core received from the Gypsy Oil Co.'s well, between the American Potash Co.'s development and one of the Government wells, was examined and found to show salts similar in character to those of the American Potash Co.'s core, the potash being contained as sylvinite and polyhalite.

The following papers were completed during the year:

- Wells, R. C., The element "mosandrum" of J. Lawrence Smith: *Washington Acad. Sci. Jour.*
 — Physico-chemical geology [book review]: *Am. Chem. Soc. Jour.*
 — Eminent chemists of our time [book review]: *Ind. and Eng. Chemistry.*
 — Note on the J. Lawrence Smith method for the analysis of samarskite: *Am. Chem. Soc. Jour.*
 — Examination of sulphuric acid for selenium: *Washington Acad. Sci. Jour.*
 — Evaporation from large bodies of water and some figures for Chesapeake Bay [to appear in *Washington Acad. Soc. Jour.*].

- Schaller, W. T. Hydroboracite from California: Festschrift Victor Goldschmidt.
 — Probable identity of camsellite with szaibelyite: *Am. Mineralogist*.
 — Occurrence of kernite and associated borates; Potash minerals from Texas-New Mexico field; Base exchange of artificial autunites [read at Cleveland meeting of Mineralogical Society of America].
 Loughlin, G. F., and Steiger, George, Indiana oolitic limestone [to be published as a Geological Survey bulletin].
 Larsen, E. S., and Steiger, George, Dehydration and optical studies of alunogen, nontronite, and griffithite: *Am. Jour. Sci.*
 Henderson, E. P., Uvarovite from California; Correlation of chemical composition and optical properties of triplite [read at Cleveland meeting of Mineralogical Society of America].
 Erickson, E. T., Qualitative tests for boron, bromine, and iodine in well cuttings and core samples of the saline fields of Texas and New Mexico [mimeographed in Geological Survey].

WORK IN PHYSICS

C. E. Van Orstrand continued in charge of the physical laboratory. He made a field trip which began March 26 and continued until the end of the fiscal year, for the purpose of taking temperature tests in deep wells near the iron mines at Birmingham, Ala., and also in the oil fields of Texas, Oklahoma, and California. A considerable portion of the time spent in the oil fields was devoted to cooperation with three research associates of the American Petroleum Institute who have adopted the apparatus developed by Mr. Van Orstrand for the purpose of making temperature tests in deep wells and who are also carrying out an extended program of research relative to the variation of temperature with structure which Mr. Van Orstrand found in some of the oil fields of California and Wyoming. The remainder of his time was devoted to administrative duties and the preparation of papers.

The testing, research, and field work of P. G. Nutting on petroleum, silica, and water have continued, covering adsorption and surface reactions with especial reference to petroleum recovery, the migration of fluids through sand and other porous bodies, the formation and accumulation of petroleum and asphalt, the association of water with minerals, the filtration of oils, bonded mixtures of fluids and solids, the deformation of granular solids, the flotation of ores, and many other problems of similar nature. Many of the results obtained have been given to the public through scientific and technical publications, and all have been available to the Geological Survey's staff.

The following papers were completed during the year:

- Van Orstrand, C. E., A machine for measuring the depths of deep wells: *Washington Acad. Sci. Jour.*
 — On the nature of isogeothermal surfaces: *Am. Jour. Sci.*
 — Measuring the depths of deep wells: *Oil and Gas Jour.*
 — The world's deepest wells and the temperatures found in some of them: *Oil and Gas Jour.*
 Nutting, P. G., Weights and temperature: *Science*.
 — The deformation of granular solids: *Washington Acad. Sci. Jour.*
 — Association of water with serpentine: *Washington Acad. Sci. Jour.*
 — Geodynamical principles [summary for geologists; not published].
 — Computing dam seepage: *Econ. Geology*.
 — Nature and action of the petroleum filtering earths: *Washington Acad. Sci. Jour.*; *Oil and Gas Jour.*
 — Petroleum and the filtering earths: *Washington Acad. Sci. Jour.*
 — Petroleum recovery by the soda process: *Oil and Gas Jour.*

ALASKAN BRANCH

PHILIP S. SMITH, *Chief Alaskan Geologist*

FUNDS

The funds used by the Geological Survey in its Alaska work are provided in two items in the general act making appropriations for the Interior Department. One of these items reads, "for continuation of the investigation of the mineral resources of Alaska, * * *". In the act for the fiscal year 1927 the amount was \$50,000; for 1928, \$60,000; for 1929, \$64,500. Each of these appropriations was available immediately on the passage of the act in which it was contained. The other item is an allotment made from the appropriation "for the enforcement of the provisions of the acts of October 20, 1914, October 2, 1917, February 25, 1920, and March 4, 1921, and other acts relating to the mining and recovery of minerals on Indian and public lands and naval petroleum reserves, * * *". Allotments under this item are available only during the fiscal year specified. In the fiscal year 1927 the allotment for this kind of work in Alaska was \$19,500; in 1928, \$14,500. The two types of work indicated will be described for convenience as the mineral-resources work and the leasing work.

MINERAL-RESOURCES WORK

PRINCIPAL RESULTS OF THE YEAR

The principal products of the Alaskan work of the Geological Survey are the reports and maps that are based on original surveys or investigations. During the year eight Alaskan reports have been issued, as follows:

- Mineral industry of Alaska in 1925, by F. H. Moffit. (Bulletin 792-A.)
- Administrative report, 1925-26, by F. H. Moffit. (Bulletin 792-A.)
- Geology of the Knik-Matanuska district, by K. K. Landes. (Bulletin 792-B.)
- The Toklat-Tonzona region, by S. R. Capps. (Bulletin 792-C.)
- Geologic investigations in northern Alaska (1925), by Philip S. Smith. (Bulletin 792-C.)
- Mineral resources of Alaska, 1925, by F. H. Moffit and others. (Bulletin 792.)
- Mineral industry of Alaska in 1926, by Philip S. Smith. (Bulletin 797-A.)
- Administrative report, 1926-27, by Philip S. Smith. (Bulletin 797-A.)

Fifteen reports that have been completed by their authors and approved for editing or printing are now in various stages of publication. These reports are as follows:

- The Upper Cretaceous floras of Alaska, by Arthur Hollick, with a description of the Upper Cretaceous plant-bearing beds, by G. C. Martin.
- The Skwentna region, by S. R. Capps. (Bulletin 797-B.)
- The Sheenjek River district, by J. B. Mertie, jr. (Bulletin 797-C.)
- Surveys in northwestern Alaska in 1926, by Philip S. Smith. (Bulletin 797-D.)
- Aerial photographic surveys in southeastern Alaska, by R. H. Sargent and F. H. Moffit. (Bulletin 797-E.)
- The Aniakchak district, by R. S. Knappen. (Bulletin 797-F.)
- Geology and mineral deposits of southeastern Alaska, by A. F. Buddington and Theodore Chapin. (Bulletin 800.)
- Geology of Hyder and vicinity, southeastern Alaska, by A. F. Buddington. (Bulletin 807.)
- Geography and geology of northwestern Alaska, by Philip S. Smith and J. B. Mertie, jr.
- The mineral industry of Alaska in 1927, by Philip S. Smith. (Bulletin 810-A.)

Administrative report, 1927-28, by Philip S. Smith. (Bulletin 810-A.)

Notes on the upper Nizina River, by F. H. Moffit.

The Mount Spurr region, by S. R. Capps.

The Chandalar-Sheenjek district, by J. B. Mertie, jr.

Geology of the Eagle-Circle district, by J. B. Mertie, jr.

Six other reports have been in course of preparation by their authors as time permitted, but no definite statement as to the time of publication can yet be made.

Practically every one of the foregoing reports is accompanied by maps, the base of which has been made principally from surveys conducted by the topographers of the Alaskan branch. Among these maps the following were completed during the year by members of the branch under the general direction of R. H. Sargent or were issued in a preliminary photolithographic edition or as sale publications:

Topographic map of northwestern Alaska, a map compiled from all available sources but mainly from surveys by the Geological Survey and including many new topographic data, derived principally from recent plane-table surveys by Gerald FitzGerald; scale, 1:500,000. Not to be issued separately from the report on northwestern Alaska by Smith and Mertie.

Topographic map of Aniakchak district, by R. H. Sargent; scale, 1:250,000. Issued in a free preliminary photolithographic edition and to be included in Bulletin 797.

Topographic map of East Fork of Chandalar-Sheenjek region, by Gerald FitzGerald and J. O. Kilmartin; surveyed on scale of 1:250,000 but compiled on scale of 1:500,000. Not to be issued separately from the report on the Chandalar-Sheenjek region by Mertie.

Drainage map of part of the Hyder-Ketchikan region, southeastern Alaska, compiled mainly from aerial photographs made by the Navy Department, at the request of the Geological Survey, especially for this work. Compilation made under direction of R. H. Sargent; scale, 1:250,000. To be included in Bulletin 797.

Preliminary topographic map of part of the Mount Spurr region, Alaska, by R. H. Sargent; scale, 1:250,000. To be included in Bulletin 810. This map will probably later be combined with other surveys and issued separately as a compiled map in a free photolithographic edition.

In addition to these more detailed maps the base map of Alaska on the scale of 1:5,000,000 was revised and brought up to date and was issued in a sale edition and as an index map to show the progress of topographic mapping in the Territory, carrying on the back a list of selected publications of the Geological Survey that describe the mineral deposits of Alaska and the features of its major geographic divisions.

In addition to these official reports several articles were prepared by the scientific and technical members or former members of the branch for publication in outside journals, and a number of public lectures were given regarding the general work of the branch or on some of its special features. Most of these articles were prepared unofficially but represent excellent by-products of the regular work and serve to reach special audiences not readily reached by the official publications. Among the articles of this sort may be mentioned the following:

Some post-Tertiary changes in Alaska of possible climatic significance, by Philip S. Smith: National Research Council Bull. 61, pp. 35-39, 1927.

The Alaskan branch of the Geological Survey, by Philip S. Smith: Min. Cong. Jour., vol. 14, pp. 165-166, 1928.

Aerial surveys in southeastern Alaska, by R. H. Sargent: Military Engineer, vol. 20, pp. 189-195, 1928.

Types of mineralization of southeastern Alaska, by A. F. Buddington: *Econ. Geology*, vol. 22, pp. 158-179, 1927.

Mineral deposits of the Hyder district, by W. B. Jewell: *Econ. Geology*, vol. 22, pp. 494-517, 1927.

The Mount Spurr region, Alaska, by S. R. Capps, report delivered at meeting of Geological Society of America, Cleveland, December, 1927.

PROJECTS IN PROGRESS DURING SEASON OF 1927

The following tables indicates the areas covered by the different types of survey in Alaska. No report is made for the field season of 1928, because that work is still in progress and its extent can not be predicted, as the parties are all out in the field beyond reach of communication. The absence of this information is relatively immaterial for practical purposes because for the field season of 1927 all of the area surveyed during that season is counted, even though part of the work was done during the fiscal year that ended June 30, 1927. Therefore the areas surveyed in the fiscal year 1927 on projects that fall within the field season of 1927 may be considered to offset the areas surveyed in the fiscal year 1928 that fall within the field season of 1928 but have been disregarded in the tabulation.

Areas surveyed by Geological Survey in Alaska, 1898-1927, in square miles

Field season	Geologic surveys			Topographic surveys		
	Exploratory (scale 1:500,000, 1:625,000, or 1:1,000,000)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)	Exploratory (scale 1:500,000, 1:625,000, or 1:1,000,000)	Reconnaissance (scale 1:250,000; 200-foot contours)	Detailed (scale 1:62,500; 25, 50, or 100 foot contours)
1898-1926	75, 150	163, 255	4, 277	55, 630	197, 400	4, 066
1927		6, 350			7, 465	
Correction	75, 150	169, 605 -300	4, 277	55, 630	204, 865 -300	4, 066
	75, 150	169, 305	4, 277	55, 630	204, 565	4, 066
Percentage surveyed of total area of Alaska	42.4			45.1		

In this table only the net areas surveyed are listed in the appropriate columns and there is no duplication of areas under "Geologic surveys" or under "Topographic surveys," though, of course, most of the areas that have been surveyed geologically have also been surveyed topographically. In other words, none of the area that is reported in the column of reconnaissance geologic surveys is also reported in the columns for geologic exploratory or detailed surveys. It is by no means unusual that in the course of later surveys it becomes desirable to revise the mapping or to resurvey on a large scale an area that had already been surveyed on a smaller scale. In order that this should not result in duplication, it is necessary to deduct the proper amount from the area previously reported. This deduction is shown as a "correction" in the foregoing table, 300 square miles covered by previously reported reconnaissance topographic and geologic surveying having been resurveyed in 1927 with greater precision.

The necessity for resurveying in more detail some areas is easily understood. For many areas in Alaska exploratory mapping is all that may be warranted at first. As development progresses more specific information may be required and a more detailed survey made, and in an intensely developed mining camp only a most detailed map would furnish the desired information. To spend money on making detailed surveys everywhere would be a waste of time and funds far more reprehensible than to resurvey different tracts here and there as conditions call for better maps. Even in some areas where it is anticipated that more detailed maps may eventually be required it has seemed best to make rapid and relatively inexpensive exploratory surveys to supply the most urgent demands for immediate information and then follow with the necessarily slower and costlier surveys. This was practically the course followed when the first stampede to Nome was in progress, for within two or three months after the return of the Federal geologist from this camp an exploratory map of the environs of Nome was published by the Geological Survey. This was succeeded the next year by reconnaissance field surveys of much of the region within a hundred miles of Nome. Only a few years later detailed mapping was undertaken of the tracts adjacent to the richest mining camps.

At present the scale adopted for most of the Alaskan work is 1:250,000, in which about 4 miles on the ground is represented by an inch on the map, with a contour interval of 200 feet. That scale is adequate for general purposes, and by its use surveys can be performed expeditiously and very cheaply. It is obvious, however, that such a scale is entirely inadequate for furnishing the more specific data required in many problems. Therefore, though the preceding table shows that about 42 per cent of the total area of Alaska has been surveyed geologically, only about 30 per cent has been surveyed on a standard that can be regarded as of reconnaissance grade. Unquestionably a greater number of detailed surveys should be made, but when it is realized that at the rate at which the work is now being done it will still be about 50 years before all the parts of the Territory that appear to show promise of containing deposits of minerals that may be of commercial value are surveyed even on a reconnaissance scale it is evident that detailed surveys are practically out of the question unless more funds are made available.

The surveys tabulated above were made in the Nizina district of the Copper River region; the district around Sheenjek River and the East Fork of the Chandalar, in the northeastern part of the Yukon Basin in Alaska; and the vicinity of Mount Spurr, in the Alaska Range.

The work in the Copper River region was in charge of F. H. Moffit, who, with a small camp equipment and one camp hand, made general reconnaissance geologic studies to obtain additional data on the occurrence of the copper deposits of that region. Much new geologic information was collected, and several areas that had been given but passing attention during the earlier surveys were more critically examined. The mining camps in the Nizina and Chitina Valleys were also visited, and late information regarding recent developments of the mineral resources of the whole district was collected.

The work in the East Fork of the Chandalar and Sheenjek district was a combined geologic and topographic reconnaissance survey in charge of J. B. Mertie, Jr., geologist, with Gerald FitzGerald, topographer, and two camp assistants. In order to utilize most effectively the short open season the topographer left Washington in February and went by ordinary means of transportation to Fairbanks, where a dog team was purchased and a camp

assistant hired. This advance party then traveled by dog team to Fort Yukon, where necessary supplies and equipment needed for the rest of the season were bought. From Fort Yukon this party, early in April, struck across country for Christian River and Arctic Village, on the East Fork of Chandalar River, having hired natives to help freight in some of the supplies. Surveys were started, and while sledding on the snow was still possible caches of supplies were distributed at selected points, so that they would be available during the summer. With the break-up of the ice on the rivers, so that travel by regular lines of transportation could be resumed, the geologist went to Fort Yukon, where, with a small load of supplies in a canoe, he and one camp hand started up Chandalar River. Travel upstream was extremely slow because of the high water in the river and the speed of the current, but eventually junction with the advance party was made and the work carried on by the combined unit. During the subsequent work travel was entirely on foot, and the only means of transporting supplies was on the backs of the men or their dogs. With the approach of cold weather the party descended East Fork of Chandalar River in skin boats until they reached the point where the geologist's canoe had been left in the spring, and then the return to Fort Yukon was made as rapidly as stops necessary to make the desired surveys permitted. The result of this work was about 3,700 square miles of geologic reconnaissance mapping and 4,900 square miles of topographic reconnaissance mapping of hitherto unmapped country and the topographic and geologic resurvey of 300 square miles of country that had been mapped with less precision in an earlier year.

The field project in the vicinity of Mount Spurr was conducted by a combined geologic and topographic party in charge of S. R. Capps, geologist, with R. H. Sargent, topographer, and four camp assistants. These surveys were essentially a continuation of those made north of Mount Spurr in 1926. Through the courtesy of the Alaska Railroad the party, with all its equipment, was landed at Trading Bay, on the west side of Cook Inlet, about the middle of June and thence proceeded westward, mapping the country as it advanced. The coastal part of the region is exceedingly difficult to traverse because of the swampy lowlands, the large streams, and the tangle of trees and brush. In the mountainous part of the region the slopes are steep, the large streams are unfordable and flow with great velocity, and glaciers protruding from the valleys block the main routes, so that passage is impossible or made only after laborious effort. Many interesting geologic and geographic facts came out of the surveys of this party besides the definite reconnaissance topographic mapping of 2,265 square miles of hitherto unmapped country and the reconnaissance geologic survey of 2,000 square miles. Among these items may be mentioned the discovery of a large river, numerous lakes, glaciers, mountains, and an active volcano. Unfortunately, the observations made by this party do not indicate that the region offers much promise of containing mineral deposits that are of present economic value.

The only other field work in progress was a general reconnaissance of several of the placer-mining camps in Seward Peninsula and of a few of the camps along the western stretches of the Yukon and in the vicinity of the Alaska Railroad. This work, which was done by Philip S. Smith, does not lend itself to expression in terms of area and was undertaken mainly to provide information regarding recent mining developments and to permit the laying out of plans for future work, so as best to fit the needs of the industry.

An important piece of work that was started in the winter of 1926-27 and will be continued for several years is the compilation and working up into maps of the aerial pictures of a large part of southeastern Alaska, taken by the Navy Department, at the request of the Geological Survey. This work has been largely under the technical direction of R. H. Sargent, with the cooperation of F. H. Moffit in special phases of the work. The photographs are prepared for cartographic use and assembled into large-scale drawings by members of the topographic branch, and the assembly sheets are then adjusted by members of the Alaskan branch to correct their scale and position and compiled. A drainage map of a tract of about 2,000 square miles that includes all of Revillagigedo Island and some of the near-by islands was completed during the year.

Another of the major projects of the branch is the annual compilation of statistics of the production of mineral commodities in the Territory. The production is reported on the basis of the calendar year, but the work of canvassing

the producers and assembling data goes on uninterruptedly throughout the year.

In addition to the office work that is an essential part of completing the current field projects, there are a number of former field projects on which the office work had not been completed during the season in which the field work was done. This work includes laboratory examination of some of the material collected, the preparation of manuscript, and the critical reading of proof. Considerable work of this sort was accomplished during the season, and as a result three reports that had been begun in earlier seasons were completed and are now in various stages of editing or publication. In all the office work on the technical reports the members of the Alaskan branch have received considerable assistance and advice from their associates in other branches of the Geological Survey. Among the special services of this sort may be mentioned the identification of the collections of fossils by the paleontologists of the geologic branch, notably G. H. Girty, J. B. Reeside, jr., and Edwin Kirk.

PROJECTS FOR THE SEASON OF 1928

The projects for the field season of 1928 had been under way only a short time at the end of the fiscal year 1928, and it is not practicable in this report to make any detailed statement of the work accomplished or to give much more than an outline of its principal objects. Six field projects were under way—reconnaissance topographic mapping in the Ketchikan region of southeastern Alaska, detailed topographic mapping on Admiralty Island, southeastern Alaska, geologic reconnaissance in the Nizina district of the Copper River region, geologic reconnaissance in the upper Tanana and Yukon regions west of the international boundary, combined geologic and topographic reconnaissance in the Alaska Range, and a general inspectional trip to check up recent mining activities and to visit some of the field parties.

The reconnaissance topographic mapping in the Ketchikan district, which is in charge of R. H. Sargent, was planned primarily to furnish an adequate topographic map of this important district. This is part of the area covered by the drainage map compiled from aerial photographs, noted above. In addition, therefore, to furnishing a useful map, this survey should supply many valuable tests by which to compare the accuracy and relative cost of the base made by phototopographic methods with those of a map made by ordinary ground methods. Very probably the tests will show that certain combinations of the two methods may be desirable.

The other topographic work in southeastern Alaska is being performed by a Geological Survey topographer, R. K. Lynt, who is attached to a timber cruising party of the Forest Service. The cost of this work is being borne entirely by the Forest Service through transfer of funds to the Geological Survey, and it is therefore not included in the table of expenditures given on page 33. The work is regarded by the Forest Service as an indispensable part of its activities in developing the paper-pulp industry of southeastern Alaska. Obviously adequate topographic maps are among the first things needed in laying out plans for the efficient and economical development of the natural resources of the region. The work will be done on a scale of 1:62,500, which is much more detailed than most of the Geological Survey's maps of Alaska, except those within the immediate neighborhood of the richest mining camps. The area covered will therefore probably be small, but the quality of the map should be excellent.

The work that is being undertaken in the Copper River region has been so planned as to form a continuation of the work that has been in progress there during the last three seasons by amplifying the observations of earlier geologists and reviewing their conclusions from the vantage ground of the added experience and information which has accumulated in the score of years that have elapsed since the earlier work was done. This work is to be done by a party consisting of F. H. Moffit and one camp assistant. These more thorough studies seem to be essential to working out the true geologic history of the region, and until that history is better understood no satisfactory conclusions can be drawn regarding the true origin of the great copper deposits of that region or their probable extension into adjacent regions where they are not yet known. In addition to these more strictly geologic duties Mr. Moffit while in the field will collect general information regarding all the mining activities in the Copper

River region and will visit such operating mines as time and other conditions permit.

The reconnaissance geologic and topographic survey in the Alaska Range region west of Mount Spurr is perhaps the most difficult project that is being undertaken in the summer of 1928. This work is in charge of S. R. Capps, geologist, with Gerald FitzGerald, topographer, and four camp assistants. The plans of the party contemplate the hire of commercial airplanes to transport perhaps half a season's supply of food and equipment and the geologist, topographer, and one assistant to a lake discovered by the party during the season of 1927, where work that joins with those earlier surveys will be started. In the meantime a pack train of 13 horses and 3 camp assistants, with supplies for half the season, will go overland to this lake by way of the trail made in 1927. The mountains will be crossed at a pass discovered and described by R. H. Merrill, an aviator whose headquarters are at Anchorage and who has made many flights across the range. The party will then carry surveys into the valleys of the streams on the west side of the range that are tributary to Kuskokwim River. If other passes across the range are discovered in the course of that work, the party in the fall may cross back to the east side of the mountains by one of them; if not, it will return by way of its outgoing route and be picked up about the middle of September at Trading Bay by a boat sent out through the courtesy of the Alaska Railroad. The geographic results of this expedition should be of great interest, as the surveys will traverse a large tract of hitherto unexplored country that has long remained a blank area on maps.

North of Tanana River adjacent to the international boundary and extending westward for more than a hundred miles is a triangular tract of country that lies south of the Fortymile placer district. A reconnaissance topographic map of this tract was made a number of years ago, but the geology was not mapped.

In this tract a geologic party in charge of J. B. Mertie, Jr., with two camp assistants and a small pack train, was to make geologic surveys during the season of 1928. A serious injury to one of the members of the party necessitated a return to Eagle in order to send the man to the hospital. As the party was too short-handed to undertake the job without additional assistance and as in that remote region it might be impossible to obtain a packer without too much delay, the original plans were suspended and alternative plans suggested. At the time that this report is submitted selection between these plans had not been made, but whatever the choice, it will involve carrying on some geologic work in the general tract between Yukon and Tanana River.

The only field work of a general character that is to be conducted by the chief Alaskan geologist during the season of 1928 is the customary broad survey of recent developments in the mining industry as a whole, with special visits to some of the more active mining camps or those that have not recently been visited by members of the Geological Survey. In the course of this work it is proposed to visit as many of the field parties and local offices as can be reached without too much delay, so as to be in close personal touch with the problems of each.

EXPENDITURES

The funds available for the regular work of the Geological Survey on Alaskan mineral resources during part of the fiscal year 1928 were appropriated in the Interior Department appropriation acts for the fiscal years 1928 and 1929. However, for the season of 1927 there was also available, until June 30, 1927, any unexpended balances from the appropriation for the fiscal year 1927. For a large part of the time, therefore, two appropriations were running concurrently. All the expenditures from these different appropriations have been properly accounted for, but the mere bookkeeping statement does not give any clear picture of the real conduct of the work. In spite of the difficulty of presenting a simple statement of the expenditures the following generalized analysis of the actual expenditures from the appropriation for 1928 may be of service:

Expenditures from funds appropriated for investigations of mineral resources in Alaska for the fiscal year 1928

Projects for season of 1927.....	\$16,180
Projects for season of 1928.....	7,560
Administrative salaries, fiscal year 1928.....	3,250
All other professional and scientific salaries, fiscal year 1928.....	24,933
All other clerical and drafting salaries.....	5,888
Office maintenance and expenses.....	1,511
Bureau of the Budget reserve.....	678
	60,000

In the first two items in the foregoing table no charges are included for salaries of any of the permanent employees of the branch, as these are all carried in the three following items. Proper proportional charges for these services, as well as for the expenditures listed as office maintenance and expenses, might well have been included in these first two items, for practically every expenditure of the branch relates directly to these projects.

The following tables prepared on a seasonal basis will make the true relation of the work to sources of funds more apparent:

Approximate cost and distribution of work by geographic divisions for the season of 1927

Region or work	Appropriation for 1927		Appropriation for 1928		Total
	Expenses	Salaries	Expenses	Salaries	
Southeastern Alaska.....			\$6,190	* \$3,332	\$9,522
Copper River.....	\$575	\$575	1,790	2,300	5,240
Alaska Range.....	1,800	1,445	4,782	6,633	14,660
Yukon.....	4,250	2,510	2,551	4,140	13,451
General.....	190		867	1,350	2,407
Mineral resources.....				* 2,133	2,133
Office work on former projects.....				4,043	4,043
	6,815	4,530	16,180	23,931	51,456

* Includes \$1,000 of drafting salaries.

* Includes \$1,683 for clerical salaries.

Approximate cost and distribution of work by geographic divisions for the season of 1928

Region or work	Appropriation for 1928		Appropriation for 1929		Total
	Expenses	Salaries	Expenses	Salaries *	
Southeastern Alaska *.....	\$1,900	\$765	\$4,700	\$3,067	\$10,432
Copper River.....	660	765	2,440	3,067	6,932
Alaska Range.....	2,600	1,445	5,800	6,230	16,075
Yukon-Tanana region.....	2,400	700	2,600	2,460	8,160
General.....			1,500	1,900	3,400
Mineral resources.....				* 1,760	1,760
Alaska district office.....					* 4,500
Office work on former projects.....				3,218	3,218
	7,560	3,675	17,040	21,682	54,457

* Exclusive of changes in rates of pay made through operation of the Welch bill.

* Exclusive of \$2,150 transferred from Forest Service for special work (\$750, 1927-28; \$1,400, 1928-29).

* Includes \$1,300 for clerical services.

* Not separately apportioned for expenses and salaries but larger part for salaries and excluded except in last column.

The item of \$3,250 for administrative salaries, shown in the table on page 33, includes only those salaries that are directly related to the administration of the work of the branch as a whole and do not include administration such as each party chief is called on to perform with regard to the units under his charge. The amount expended for administration is exceedingly low, because much of the time of the principal administrative officer is spent on specific technical and related projects, which therefore bear their proportional share of the charge for his salary. Although this practice undoubtedly makes the cost of administration low, it is not regarded as good because it leads to the loss of real directive handling of many matters. With the present personnel of the Alaskan branch, made up of men long familiar with the work and well qualified to solve many of the problems as they arise, the loss is not so apparent, but it is believed to be no less real.

The item of expenditures for clerical and drafting salaries covers the salary of a chief clerk, Miss L. M. Graves, a junior clerk, and a draftsman. Part of the pay of the chief clerk is included in the item for administration, as during much of the field work she is in charge of the office. Three-quarters of the time of the junior clerk is devoted to the computation of the statistics of the production of minerals and work related thereto. The drafting work of the branch is done by J. B. Torbert. The clerical personnel is entirely too small to handle the large volume of work expeditiously and thoroughly, but it has been cut down to the lowest limits to provide funds for the important field projects.

Only about $2\frac{1}{2}$ per cent of the entire appropriation for Alaska work was spent for items that are included in the table as office maintenance and expenses. This item does not cover purchases of supplies and equipment for specific field projects, as those expenses are included in the allotments for the individual projects. It does, however, include the general repair of all instruments or the purchase of such instruments and material to be used in the field as are not directly assigned to an individual project.

LEASING WORK

The leasing work in Alaska in 1928 was conducted from an allotment of \$14,500 made from a separate item in the appropriation for the Geological Survey. The general conduct of the leasing work in Alaska is shared between the conservation branch and the Alaskan branch. Local offices are maintained at Juneau and Anchorage, Alaska, in charge of B. D. Stewart, supervising mining engineer, with a staff of two other engineers, together with the necessary clerical assistance.

The Territorial Government of Alaska cooperates in some of the work conducted under this allotment to the extent of furnishing office facilities and clerical services at Juneau and supplying funds for such travel expenses as are performed in the interests of the Territory. This arrangement eliminates much duplication that would be necessary if the Federal and Territorial Governments each maintained separate organizations to conduct the work desired by them, much of which is identical in character.

The primary purpose of these local offices in Alaska is to supervise the operations under the coal and oil leases issued by the Government.

Nearly all the coal mining and much of the oil drilling in Alaska is done on public lands held temporarily by private individuals or companies under leases or permits. The interest of the Government in these lands requires that the developments shall be supervised so as to insure that proper methods of extracting the minerals are employed and undue waste thus prevented and that the lives, health, and welfare of those employed in the work are properly safeguarded. The coal-mining developments are carefully supervised, and wherever possible assistance is given to the operators by outlining and putting into effect economical and safe development and mining programs. Special attention is given to the installation and maintenance of safe and efficient hoisting and tramming equipment; to mine ventilation; to the reduction of fire, explosion, and blasting hazards; and to the provision of adequate pillars in advance of all mining operations. During the year there was one fatality in connection with coal mining—the second to occur during a period of six years—one accident that resulted in permanent partial disability, and four serious and four slight accidents that together caused the injured employees a loss of time amounting to 147 days. This record is exceedingly good, as on the average 95 men were employed throughout the year in coal mining and about 32,000 man-shifts were worked.

The care and maintenance of the coal properties and equipment that the Government owns at Eska, Chickaloon, Sutton, and Coal Creek devolves upon the members of this unit. All these properties are now idle, but the Eska mine and camp are kept in condition for immediate reopening in case an emergency should arise that might jeopardize the coal supply for the Alaska Railroad.

During the season of 1927 it was also practicable for the engineers attached to the local offices in Alaska to conduct general investigations and be of assistance to miners in many of the districts of southeastern Alaska and in the country adjacent to the Alaska Railroad. Work of this kind was done at Taku River, Windham Bay, Chichagof Island, Hyder, Chickamin River, and Willow Creek.

Their familiarity with mining matters throughout many parts of the Territory and their availability for consultation enabled Mr. Stewart and his staff to give much valuable information and advice to many of the Federal and Territorial agencies in Alaska, as well as to many individuals, including the Alaska Railroad, the Forest Service, the governor, members of the Territorial legislature, and many operators and prospectors. The Alaska offices also act as local distribution offices for handling publications of the Geological Survey and assist in furnishing the main office at Washington with information on many phases of the mineral industry.

During the fiscal year funds expended by this office were distributed approximately as follows:

Administrative salaries.....	\$3, 200
Other technical salaries.....	8, 000
Clerical salaries.....	1, 500
Field and office expenses.....	1, 800
	<hr/>
	14, 500

Much of the time of the administrative officer in Alaska is given to field work and other duties not regarded as strictly administrative in character, so that only a proportional part of his salary is charged

as a direct administrative expense and the rest is included in the item "Other technical salaries."

Some of the activities of the members of the Alaskan branch who have been paid from appropriations for the leasing work can not strictly be considered as closely related to that work. To remove any possible difficulties that might arise from this condition, it was decided to carry the two different kinds of work in separate appropriations. In the appropriations for 1929 \$4,500 was added to the amount for investigating the mineral resources of Alaska, to cover work of this type, and the appropriation for leasing work was reduced a similar amount. Henceforth, therefore, the two kinds of work will be accounted for separately, and for the fiscal year 1929 the amount allotted to the strictly leasing work will be \$10,000. No decided change is contemplated in the future handling of either phase of the work. The result of the separation of funds should be not only to get on a strictly accurate basis but also to give greater flexibility to the use of the funds appropriated for the general investigative work and place more definitely the responsibility for planning the use of those funds so that they may be used to best advantage by removing duplication and causing closer coordination between all the units that have a share in fostering the mineral industry of the Territory.

TOPOGRAPHIC BRANCH

C. H. BIRDSEYE, Chief Topographic Engineer

ORGANIZATION AND PERSONNEL

The organization of the topographic branch at the end of the year remains unchanged.

The technical force at the end of the year comprised 1 chief topographic engineer, 3 senior topographic engineers in charge of divisions, 12 topographic engineers, 2 geodetic engineers, 126 associate, assistant, and junior topographic, geodetic, or cartographic engineers, and 52 engineering field aides and draftsmen of various grades, a total of 196. The clerical force comprised 13 clerks.

EXPENDITURES

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1928

State or project	Appropriation for topographic surveys	Repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Topographic surveys, 1928.....	\$510, 200. 00	\$39, 491. 33	\$549, 691. 33	\$396, 962. 87	\$946, 654. 20
Bureau of Mines transfer (helium).....	4, 600. 00	-----	4, 600. 00	-----	4, 600. 00
Great Smoky National Park, 1928-29....	2, 949. 16	-----	2, 949. 16	-----	2, 949. 16
Shenandoah National Park, 1928-29.....	2, 562. 46	-----	2, 562. 46	-----	2, 562. 46
Credits on account of refunds.....	293. 95	-----	293. 95	-----	293. 95
Total funds available.....	520, 605. 57	39, 491. 33	560, 096. 90	396, 962. 87	947, 059. 77
Expenditures:					
Alabama.....	10, 017. 60	-----	10, 017. 60	10, 000. 00	20, 017. 60
Arizona.....	7, 059. 64	-----	7, 059. 64	-----	7, 059. 64
Arkansas.....	5, 207. 86	46. 65	5, 254. 51	5, 050. 00	10, 304. 51
California.....	20, 332. 39	-----	20, 332. 39	17, 897. 14	37, 229. 53
Colorado.....	12, 299. 98	-----	12, 299. 98	8, 982. 46	21, 282. 44
Connecticut.....	-----	-----	-----	361. 73	361. 73
Hawaii.....	24, 479. 37	-----	24, 479. 37	24, 779. 61	49, 259. 98

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1928—Continued

State or project	Appropriation for topographic surveys	Repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Expenditures—Continued.					
Idaho.....	\$11, 146. 93	\$2, 897. 32	\$11, 044. 25		\$14, 044. 25
Illinois.....	65, 406. 70	693. 82	66, 100. 52	\$63, 701. 60	119, 802. 02
Iowa.....	2, 350. 72		2, 350. 72	1, 337. 60	3, 688. 32
Kansas.....	1, 902. 76		1, 902. 76		1, 902. 76
Kentucky.....	10, 746. 06		10, 746. 06	37, 763. 98	48, 510. 04
Maine.....	45, 460. 45	7, 591. 98	53, 052. 43	26, 982. 39	80, 034. 82
Michigan.....	18, 302. 71		18, 302. 71	14, 611. 80	32, 914. 51
Mississippi.....		179. 34	179. 34		179. 34
Missouri.....	2, 734. 01		2, 734. 01	163. 35	2, 897. 36
Montana.....	5, 687. 50		5, 687. 50	1, 873. 08	7, 560. 58
Nevada.....		849. 12	849. 12		849. 12
New Hampshire.....	23, 688. 57	7, 247. 29	30, 935. 86	18, 677. 56	49, 613. 42
New Mexico.....	15, 778. 00		15, 778. 00	11, 273. 15	27, 051. 15
New York.....	8, 700. 95		8, 700. 95	17, 562. 67	26, 263. 62
North Dakota.....	13, 817. 07		13, 817. 07	10, 360. 33	24, 177. 40
Oklahoma.....	15, 610. 29	39. 44	15, 649. 73	16, 433. 27	32, 083. 00
Oregon.....	13, 365. 02		13, 365. 02	897. 55	14, 262. 57
Pennsylvania.....	27, 663. 30		27, 663. 30	19, 069. 70	46, 733. 00
Tennessee.....	10, 006. 16		10, 006. 16	12, 996. 76	23, 002. 92
Texas.....	15, 853. 78	1, 460. 38	17, 314. 16	9, 504. 47	26, 818. 63
Utah.....	6, 750. 04		6, 750. 04	1, 439. 65	8, 189. 69
Vermont.....	5, 044. 50	2, 655. 57	7, 700. 07	5, 577. 46	13, 277. 53
Virginia.....	28, 194. 58		28, 194. 58	39, 838. 45	68, 033. 03
Washington.....	10, 135. 98		10, 135. 98	2, 538. 49	12, 674. 47
West Virginia.....	2, 435. 36		2, 435. 36	2, 496. 49	4, 931. 85
Wisconsin.....	10, 320. 33		10, 320. 33	15, 359. 21	25, 679. 54
Wyoming.....	6, 690. 24		6, 690. 24		6, 690. 24
Books for library.....	114. 82		114. 82		114. 82
Computing.....	* 4, 264. 36		4, 264. 36		4, 264. 36
Contingent.....	16, 783. 52		16, 783. 52		16, 783. 52
D. C. map revision.....	1, 296. 63		1, 296. 63		1, 296. 63
Field distribution offices.....	1, 034. 84		1, 034. 84		1, 034. 84
Field instruments.....	* 4, 735. 70		4, 735. 70		4, 735. 70
Field stationery.....	210. 00		210. 00		210. 00
Inspection and editing.....	* 7, 716. 87		7, 716. 87		7, 716. 87
Map information.....	3, 084. 26		3, 084. 26		3, 084. 26
One-millionth maps.....	7, 113. 79		7, 113. 79		7, 113. 79
Miscellaneous repay.....		15, 830. 42	15, 830. 42		15, 830. 42
Office salaries.....	* 7, 465. 77		7, 465. 77		7, 465. 77
Photographic mapping.....	* 2, 368. 54		2, 368. 54		2, 368. 54
Relief maps.....	755. 16		755. 16		755. 16
Total expenditures.....	\$ 514, 133. 11	39, 491. 33	553, 624. 44	386, 962. 87	940, 587. 31
Unexpended balance.....	6, 472. 46		6, 472. 46		6, 472. 46
	520, 605. 57	39, 491. 33	560, 096. 90	386, 962. 87	947, 059. 77

* Represents 35 per cent of total cost; balance of 65 per cent included in charges for State cooperation.
 † \$386,231.83 expended on State cooperation.

GENERAL OFFICE WORK

General office work consisted in the inking and inspection and editing of the topographic field sheets prior to their submission for reproduction, in the computation and adjustment of the results of control field work, and in the preparation of partial culture and drainage bases from aerial photographs. In cooperation with the State Highway Department of New Hampshire a shaded relief and highway map of New Hampshire was compiled. In cooperation with the Virginia Geological Survey a contour map of Virginia was compiled. Cooperation with the Air Corps, United States Army, was continued whereby aerial photographs were furnished for use in topographic mapping. (See also p. 72.)

SUMMARY OF RESULTS

The status of topographic surveys on June 30, 1928, is shown in the following table:

New topographic surveys of the United States, July 1, 1927, to June 30, 1928, and total area surveyed in each State

State	Publication contour interval (feet)	Mapped in fiscal year (square miles) for publication on scale of 1 to—					Total area mapped in fiscal year (square miles)		Total area mapped to June 30, 1928 (square miles)	Percentage of total area of State mapped to June 30, 1928	River surveys, scale 1:48,000 (linear miles)	Spirit levels (miles)	Transit traverse (miles)	Triangulation stations occupied
		12,000	20,000	24,000	31,680	48,000	62,500	125,000						
Alabama	20						142		21,240	40.8		387	226	
Arizona	100							386	58,398	51.3				
Arkansas	20								21,730	40.7		266		
California	5, 10, 20			29	830				125,921	79.5		252	30	44
Colorado	25, 50, 100	33		75					55,530	53.4		160	20	
Connecticut									4,965	100.0		13		
Delaware	10						53		2,370	100.0				
District of Columbia	10				42				70	100.0				
Florida							42		4,716	8.0				
Georgia									24,835	41.9				
Idaho	2, 100	15							30,446	36.3				
Illinois	5, 10, 20			260					30,513	53.8		846	416	
Indiana	5			3			1,608		3,665	10.1				
Iowa	20						181		13,023	23.2		68		
Kansas									64,159	78.0				
Kentucky	20						977		23,232	57.2		573	669	
Louisiana	20						13		8,823	18.2				
Maine	20			1			1,083		13,335	40.3		491	126	83
Maryland	10				193				12,327	100.0				
Massachusetts									8,266	100.0		223	492	
Michigan	10, 20		11				598		12,938	22.4				
Minnesota									7,354	8.7		3		
Mississippi									3,881	8.3				
Missouri	20						32		43,083	62.1				
Montana	2, 5, 100	1					243		41,834	28.7	14	55		
Nebraska									27,117	35.0		15		
Nevada							933		44,642	40.3				
New Hampshire	20			1					7,157	76.6		410	16	1
New Jersey									8,224	100.0				
New Mexico	25, 50								41,510	38.9		292		29
New York	10, 20	51					280		49,245	100.0				
North Carolina							31		19,034	36.3				
North Dakota	10, 20			61			740		12,189	17.1		249	339	
Ohio									41,040	100.0				
Oklahoma	20						476		40,284	57.7		504	122	
Oregon	100						763		30,650	31.7		387		
Pennsylvania	50								34,869	77.3		387	554	
Rhode Island									1,248	100.0				

FIELD SURVEYS

Alabama.—In cooperation with the State geologist of Alabama the resurvey of the Searles and Cottdale quadrangles (previously surveyed on a smaller scale) was begun.

Arizona.—At the request of the Forest Service the resurvey of the Turret Peak quadrangle (previously surveyed on a smaller scale) was begun.

Arkansas.—In cooperation with the State geologist of Arkansas the survey of the El Dorado quadrangle was completed.

California.—In cooperation with the State engineer of California the survey of the Pond, Wasco, Famosa, Jasmine, Semitropic, Wheatville, Hamlin School, Miramonte Ranch, No. 28, No. 29, No. 31, No. 32, No. 60, and No. 64 quadrangles was completed. At the request of the geologic branch the survey of the Elk Hills naval reserve was completed.

Colorado.—In cooperation with the Colorado Metal Mining Fund the survey of the Climax mining district was completed and that of the Mosquito Range mining region and the Ouray mining district was begun. At the request of the Forest Service the survey of the Glenwood Springs quadrangle was completed.

Delaware.—The resurvey of the Noxontown Pond and Bay Side quadrangles (previously surveyed on a smaller scale) was completed.

Hawaii.—In cooperation with the commissioner of public lands of the Territory of Hawaii the survey of the Humuula NE. $\frac{1}{4}$, Humuula SE. $\frac{1}{4}$, Honolulu, and Barbers Point quadrangles was completed and that of the Wahaiwa, Wala-nac, Mokapu, Kaneohe, Walpaho, Ewa, Koko Head, and Schofield quadrangles, on the island of Oahu, was begun.

Idaho.—At the request of the geologic branch the survey of the Bay Horse quadrangle was begun. At the request of the Forest Service the survey of the Newsome quadrangle was begun. At the request of the State Department the survey of Kootenai River was begun.

Illinois.—In cooperation with the Department of Registration and Education of Illinois, Geological Survey, the survey of the Danvers, Edwardsville, Glasford, Hardin, Pearl, Alton, Bonfils, and Brussels quadrangles and the northern part of the Dyer, Steger, Frankfort, and Brisbane quadrangles was completed; that of the Mackinaw, Meredosia, Arenzville, Morrison, Thebes, Mound City, Hettick, Hannibal, and Barry quadrangles was begun; that of the Manito quadrangle was continued; and the resurvey of the Calumet Lake, Blue Island, and Mokena quadrangles (previously surveyed on a smaller scale) was completed, and that of the Geneva quadrangle was begun.

Indiana.—The survey of the northern part of the Dyer quadrangle was completed.

Iowa.—In cooperation with the Geological Survey of Iowa the survey of the Bondurant quadrangle was completed, and that of the Indianola quadrangle was begun.

Kentucky.—In cooperation with the State geologist of Kentucky the survey of the Lexington, Big Clifty, and La Grange quadrangles was completed and that of the Joppa, Eddyville, Pleasureville, Adolphus, Buck Lodge, and Burnside quadrangles was begun.

Louisiana.—The survey of the El Dorado quadrangle was completed.

Maine.—In cooperation with the Public Utilities Commission of Maine the survey of the Rumford, Stockholm, Square Lake, and Katahdin quadrangles was completed; that of the Stratton quadrangle was continued; and that of the Spencer, Great Pond, Upper Lake, and Eagle Lake quadrangles was begun. In cooperation with the War Department the survey of the Sandy Bay, Moose Bog, and Second Lake quadrangles was completed.

Maine-New Hampshire.—In cooperation with the Highway Commission of Maine and the Highway Department of New Hampshire a survey of the boundary between these two States north of the outlet of Great East Pond was begun.

Michigan.—In cooperation with the Department of Conservation of Michigan, Geological Survey, the survey of the Benton Harbor, Breedsville, Niles, and Hartford quadrangles was completed and that of the Marcellus, Gobleville, Fletcher, and Fennville quadrangles was begun.

Missouri.—In cooperation with the State geologist of Missouri the survey of the Coldwater quadrangle was completed and the resurvey of the Fulton No. 2 quadrangle (previously surveyed on a smaller scale) was continued.

Montana.—At the request of the geologic branch the survey of the Libby quadrangle was begun. In cooperation with the State engineer of Montana a survey in the vicinity of Flathead Lake was begun.

New Hampshire.—In cooperation with the Highway Department of New Hampshire the survey of the Danbury, Mascoma, Bellows Falls, and Sliver Lake quadrangles was completed and that of the Rumney and Campton quadrangles was begun. In cooperation with the War Department the survey of the Second Lake and Moose Bog quadrangles was completed.

New Mexico.—In cooperation with the State engineer of New Mexico the survey of the Tucumcari quadrangle was completed and the resurvey of the Sulphur Spring quadrangle—previously surveyed on a smaller scale—was begun.

New York.—In cooperation with the Department of Public Works of New York the resurvey of the Schenectady quadrangle was completed and that of the Amsterdam quadrangle was begun. In cooperation with the commissioners of the Palisades Interstate Park the survey of the Palisades Interstate Park was completed.

North Carolina.—The survey of the Stuart quadrangle was begun.

North Dakota.—In cooperation with the State engineer of North Dakota the survey of the Drake, Hamar, and Peking quadrangles was completed; that of the Tokio, Skogmo, Devils Lake, and Oberon quadrangles was begun, and that of the Souris River was extended.

Oklahoma.—In cooperation with the Highway Commission of Oklahoma the survey of the McLoud and Drumright quadrangles was completed and that of the Yale, Skedee, and Stroud quadrangles was begun.

Oregon.—At the request of the Forest Service the survey of the Mount Jefferson quadrangle was completed. In cooperation with the State engineer of Oregon the survey of the Madras quadrangle was begun.

Pennsylvania.—In cooperation with the Department of Internal Affairs of Pennsylvania, Topographic and Geologic Survey, the survey of the Eagles Mere, Townville, Tidioute, Titusville, Hyndman, and Clearville quadrangles was completed and that of the Ariel and Snowshoe quadrangles was begun.

Tennessee.—In cooperation with the State geologist of Tennessee the survey of the Erin and Red Boiling Springs quadrangles was completed, that of the Monoville quadrangle was begun, and the resurvey of the Middlesboro quadrangle (previously surveyed on a smaller scale) was completed.

Texas.—In cooperation with separate interests acting through the Board of Water Engineers of Texas the survey of the Lufkin 4-c, Lufkin 4-d, and Zavalla 3-c quadrangles of the Neches River project was completed and that of the Lufkin 3-a and Lufkin 3-d quadrangles was begun. In cooperation with the Board of Water Engineers of Texas the survey of the Frio River reservoir site, near Dilley, was completed and that of the Floresville quadrangle was begun. In cooperation with the Reclamation Department of Texas the survey of the Sulphur River project, in the vicinity of Long Lake, and the Little River project, in the vicinity of Reeds Lake, was completed. At the request of the Bureau of Mines large-scale surveys were begun in the vicinity of Amarillo. The survey of the Bassett quadrangle was completed.

Utah.—In cooperation with Salt Lake County and the Bureau of Reclamation the survey of this county was continued. At the request of the geologic branch a survey of the East Tintic mining district was completed and that of the North Tintic mining district was begun.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Hyde Park quadrangle was completed. In cooperation with the War Department stream surveys were begun for navigation, power development, flood control, and irrigation. In cooperation with the Vermont Flood Control Commission stream surveys were begun for flood control.

Virginia.—In cooperation with the Conservation and Development Commission of Virginia, Geological Survey, the resurvey of the Remington, Speedwell, Max Meadows, and Middlesboro quadrangles was completed and that of the Bonsacks, Salem, and the tentative boundary of the proposed Shenandoah National Park was begun (areas previously surveyed on a smaller scale), and the survey of the Stuart quadrangle was begun.

Washington.—In cooperation with the Department of Conservation and Development of Washington the survey of the Chewelah quadrangle was completed and that of the Colville quadrangle was begun.

West Virginia.—In cooperation with the acting State geologist of West Virginia the culture was revised for the Montgomery, Bald Knob, and Fayetteville quadrangles and cultural revision was begun for the Eccles, Beckley, and Flat-top quadrangles.

Wisconsin.—In cooperation with the Geological and Natural History Survey of Wisconsin the survey of the Strum, La Crosse, and La Crescent quadrangles

was completed, that of the Shamrock quadrangle was continued, and that of the Alma, Mondovi, and Durand quadrangles was begun.

Wyoming.—At the request of the geologic branch the survey of the Cheney quadrangle was begun.

WATER-RESOURCES BRANCH

N. C. GROVER, Chief Hydraulic Engineer

ORGANIZATION AND PERSONNEL

The organization of the water-resources branch is the same as last year, and the changes in personnel show a net increase of 13. At the end of the year the force comprises 131 technical and 23 clerical employees.

FUNDS

The funds available for disbursement by the Geological Survey for the work on water resources were as follows:

Gaging streams	\$147,000.00
Transfers from Federal agencies	47,886.23
Repayments by Federal agencies	40,448.42
Funds furnished by States and other non-Federal governmental agencies	338,818.81
Funds furnished by permittees and licensees of the Federal Power Commission	32,424.71
	<hr/>
	606,578.17

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Arizona	\$20,381.97
Arkansas	2,713.31
California:	
State	\$24,790.29
County and city (gaging streams)	13,890.18
Municipal (ground water)	9,169.20
	<hr/>
	47,858.67
Colorado	617.85
Connecticut	1,359.42
Hawaii:	
Territory	\$29,702.90
Municipal	3,679.75
	<hr/>
	33,382.65
Idaho	16,979.87
Illinois	4,658.22
Maine	6,113.57
Maryland (municipal)	130.44
Massachusetts	5,323.09
Minnesota	296.00
Missouri	8,324.56
Montana:	
Gaging streams	\$6,096.93
Ground water	1,334.24
	<hr/>
	7,431.17

Nevada-----		\$1, 147. 62
New Hampshire-----		2, 409. 72
New Jersey:		
Gaging streams-----	\$11, 674. 02	
Ground water-----	1, 585. 15	
		13, 259. 17
New Mexico:		
State (gaging streams)-----	500. 00	
State (ground water)-----	4, 289. 88	
County (ground water)-----	1, 665. 91	
		6, 455. 79
New York:		
State-----	17, 086. 96	
Municipal-----	478. 65	
		17, 565. 61
North Carolina-----		11, 168. 35
Ohio-----		30, 116. 57
Oregon-----		7, 085. 45
Pennsylvania (ground water)-----		433. 32
Tennessee-----		13, 284. 84
Texas-----		32, 107. 03
Utah-----		7, 469. 74
Vermont-----		2, 596. 42
Virginia-----		16, 824. 47
Washington:		
State-----	\$7, 760. 85	
Municipal-----	1, 393. 55	
		9, 154. 40
West Virginia-----		228. 82
Wisconsin-----		6, 439. 97
Wyoming-----		5, 500. 73
		338, 818. 81

The work done under cooperative agreements with States and municipalities has been restricted to studies of stream flow, except in California, Idaho, Montana, New Jersey, New Mexico, Pennsylvania, and Tennessee, where ground-water investigations have been made. (pp. 49-50.)

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects was continued in cooperation with the Bureau of Reclamation on the Black Canyon and Yakima projects and on the lower Colorado River. A geologic investigation was made for the Bureau of Reclamation in New Mexico.

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued in the Colville, Western Shoshone, and Walker River Reservations and on the Zuni and San Carlos Rivers. A geologic investigation was made of the Zuni Dam in New Mexico.

National Park Service.—Streams in the Yellowstone National Park were measured during the year at stations maintained in cooperation with the National Park Service.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service.

Weather Bureau.—Stream gaging has been continued on Colorado River in Arizona in cooperation with the Weather Bureau.

Bureau of Mines.—A report on a ground-water supply near Amarillo, Tex., was made to the Bureau of Mines.

Department of State.—Stream gaging for the Department of State has been continued on the Rio Grande on the Mexican boundary.

and on St. Mary and Milk Rivers on and near the Canadian boundary. At the end of the year the work on the Canadian boundary was being extended to include Kootenai River, and plans had been made for establishing, during the next year, gaging stations on the Skagit, the Columbia and its tributaries that cross to or from Canada, and the Roseau. The cost of all this work is being met by funds transferred to the Geological Survey from the Department of State.

Corps of Engineers, United States Army.—Stream gaging has been continued in the basins of Tennessee and Cumberland Rivers. During the later part of the fiscal year arrangements were made with several of the district engineers of the Corps of Engineers for the Geological Survey to conduct the stream gaging needed in connection with studies and reports to be made under House Document No. 308 of the Sixty-ninth Congress, first session. Such arrangements have been made with the district engineers of the Army at Boston, Providence, New York, Philadelphia, Washington, Norfolk, Huntington, Chattanooga, Nashville, Florence, Montgomery, Mobile, Jacksonville, Vicksburg, Louisville, Cincinnati, St. Paul, Kansas City, Seattle, Portland, and San Francisco. At the end of the year the work of selecting sites and establishing and equipping the stations was in progress. The cost of this work is being reimbursed to the Geological Survey from funds of the Corps of Engineers.

Federal Power Commission.—The stream gaging required by the Federal Power Commission in permits and licenses issued for the development of water power under the Federal water power act has been performed or supervised by engineers of the Geological Survey in Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Maine, Michigan, Minnesota, Missouri, Montana, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming. The operation of constructed projects or those under construction has been supervised in Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wisconsin, and Wyoming.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 10 reports and 7 separate chapters. At the end of the year 14 other reports were in press, 7 manuscripts were awaiting editorial work, and 23 were awaiting funds for publication.

CHARACTER AND METHOD OF WORK

The study of surface waters, which consists primarily of the measurement of the flow of streams, has been conducted in 40 States and Hawaii at selected gaging stations at which the volume of water carried by the streams is measured and records of stage and other data, from which the daily flow of the stream is computed, are collected. At the end of the year 1,830 gaging stations were being maintained; 249 stations were discontinued and 330 new stations established during the year. Records for about 130 additional stations were received, ready for publication, from Government bureaus and private persons, and a number of Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

The division of ground water investigates the waters that lie below the surface; their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to the chemical composition of the water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects. During the fiscal year about 40 investigations relating to ground-water and reservoir sites were in progress, and work was conducted in 15 States. The demands of the public for precise information in regard to ground-water resources are becoming more and more exacting with increasing need for the water. In recent years considerable research into the principles of ground-water hydrology has been undertaken in the division in order to provide a more secure basis for ground-water investigations. Critical studies are in progress in regard to the laws of head and flow of artesian water, the principles of recharge and discharge of ground water, fluctuations of the water table, and the relation of vegetation to ground water. In connection with these studies a hydrologic laboratory and three experiment stations have been maintained, about 30 automatic water-stage recorders have been installed over observation wells, and thousands of measurements of water levels in wells have been made. A paper on the compressibility and elasticity of artesian aquifers, by O. E. Meinzer, was published in *Economic Geology*. Considerable attention has also been given by Mr. Meinzer to the occurrence and behavior of ebbing and flowing springs and the history of the science of ground-water hydrology in this country and in Europe. In recent years most of the geologic investigations of reservoir sites have been made by this division, and much attention has been given to the principles involved and to the available methods of investigation. A systematic effort is made to maintain contact with European hydrologists, and abstracts of papers published in this country on ground-water hydrology are furnished to the *Revue de Géologie* and the *Zentralblatt*. Cooperation was continued with the State associations of water-well drillers in North Dakota, Minnesota, Wisconsin, and Illinois. In February Mr. Meinzer addressed a conference of Illinois drillers at Urbana and assisted in the organization of the Illinois Association of Water-Well Drillers. He also addressed the annual convention of the Minnesota Well Drillers' Association, and has acted as chairman of a committee that was called to organize the American Association of Water-Well Drillers.

The work on quality of water involved the examination of 550 samples of water with reference to their dissolved mineral matter and of 251 samples of silt taken in connection with the study of the silt carried by streams. The samples analyzed included some for nearly all the studies of ground water in the different States as noted below. Manuscripts were prepared by C. S. Howard on the chemical char-

acter of the water of Colorado River and on the silt carried by the river. A summary of the results of this work was presented by W. D. Collins and Mr. Howard at the St. Louis meeting of the American Chemical Society in April, 1928, and published in *Industrial and Engineering Chemistry*.

The work of the division of power resources comprised the preparation of monthly and annual reports of the production of electricity and consumption of fuel by public-utility power plants, a report of the developed water power of the United States, and compilations of the stocks of coal held by electric public-utility power plants for inclusion in reports of commercial stocks of coal undertaken quarterly by the Bureau of Mines of the Department of Commerce. The monthly and annual figures of output of electricity and fuel consumption are based on reports submitted by concerns producing electricity for public use. On January 1, 1928, 1,820 companies operating 3,705 power plants with a total capacity of generators of 27,691,000 kilowatts were on the list of companies requested to submit reports of the operation of their power plants. Plants whose output is less than 10,000 kilowatt-hours a month are not included. Reports are received from plants representing over 95 per cent of the capacity of all plants listed. The output of plants not reporting is estimated.

Annual production of electricity by public-utility power plants in the United States, 1919-1927

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from preceding year	Kilowatt-hours	Per cent of total	Change from preceding year	Kilowatt-hours	Per cent of total	Change from preceding year
		Per cent			Per cent			Per cent
1919.....	38,921,000,000		14,606,000,000	37.5		24,315,000,000	62.5	
1920.....	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921.....	40,975,000,000	-5.9	14,970,000,000	36.5	-7.3	26,005,000,000	63.5	-8.1
1922.....	47,654,000,000	+16.3	17,207,000,000	36.1	+14.9	30,447,000,000	63.9	+17.1
1923.....	55,665,000,000	+16.8	19,343,000,000	34.8	+12.4	36,322,000,000	65.2	+19.3
1924.....	59,014,000,000	+6.0	19,969,000,000	33.8	+3.2	39,044,000,000	66.2	+7.5
1925.....	65,870,000,000	+11.6	22,356,000,000	33.9	+11.9	43,514,000,000	66.1	+11.4
1926.....	73,791,000,000	+12.0	26,189,000,000	35.5	+17.1	47,602,000,000	64.5	+9.4
1927.....	80,205,000,000	+8.7	29,875,000,000	37.2	+14.1	50,330,000,000	62.8	+5.7

Annual consumption of fuel in the production of electricity by public-utility power plants in the United States, 1919-1927

Year	Coal		Fuel oil		Gas	
	Short tons	Change from preceding year	Barrels	Change from preceding year	M cubic feet	Change from preceding year
		Per cent		Per cent		Per cent
1919.....	35,100,000		11,050,000		21,406,000	
1920.....	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921.....	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.1
1922.....	34,179,000	+8.2	13,197,000	+9.6	27,172,000	+14.5
1923.....	38,966,000	+14.0	14,684,000	+11.3	31,483,000	+15.8
1924.....	37,556,000	-3.6	16,630,000	+13.3	48,443,000	+53.7
1925.....	40,222,000	+7.1	10,246,000	-38.4	46,521,000	-4.3
1926.....	41,311,000	+2.7	9,399,000	-8.3	53,207,000	+14.6
1927.....	41,888,000	+1.4	6,782,000	-27.8	62,919,000	+18.6

The improvement in the utilization of fuel in the generation of electricity by public-utility power plants is shown in the following table:

Average consumption of coal^a per kilowatt-hour by public-utility power plants in the United States, 1919-1927

Year	Pounds	Per cent of rate in 1919	Year	Pounds	Per cent of rate in 1919
1919	3.2	100	1924	2.2	69
1920	3.0	94	1925	2.1	66
1921	2.7	84	1926	1.95	61
1922	2.5	78	1927	1.84	57
1923	2.4	75			

^a Oil and gas included as equivalent coal.

The improvement year by year in the utilization of fuel in the generation of electricity is of special interest. This improvement has conserved a large amount of fuel, as, although the production of electricity by the use of fuels in 1927 was more than double that for 1919, the consumption of fuels in 1927 was only 18 per cent more than in 1919. The use of water power since 1919 in the production of electricity, notwithstanding the remarkable increase in the efficiency of fuel-burning plants, has maintained its position and during the last three years has shown a relative increase in production of electricity as compared with the amount of electricity produced by fuel. Water Supply Paper 579, Power Capacity and Production in the United States, which contains the monthly figures of production of electricity from 1919 to 1926, as well as a large amount of information about power and its use, was released in March, 1928.

The investigation of the water-power and irrigation resources of the public lands has been continued during the year in areas designated and with the use of funds provided by the conservation branch. The work has been done by a small personnel working from three field offices, one of which was discontinued early in the year. It has consisted of the examination of streams, including the location and survey of power and reservoir sites and of neighboring lands to determine their value for power or irrigation and the preparation of reports, either for office use or for publication, on the power value of streams.

WORK OF THE YEAR BY STATES

The following table shows by States the number of gaging stations maintained for the collection of stream-flow records and the interest in those stations of the agencies cooperating with the Geological Survey:

Gaging stations and cooperating parties for the year ended June 30, 1928

State or Territory	Geo- logical Survey alone	Recla- mation Service	Forest Service	Indian Office	Army engi- neers	Weather Bureau	Other Federal bureaus	State cooper- ation	Munici- pal cooper- ation	Private persons	Counted more than once	Maintained at end of year	Estab- lished during year	Discon- tinued during year	Regular gagings during year	Miscel- laneous gagings during year
Alabama					14			1		8	2	21	8	2	92	11
Arizona		1		3		3		48	6		18	18	3		990	2
Arkansas						3		12		8	12	12	14	3	70	6
California			20	1		8	6	223	63	100	187	225	14	14	3,283	381
Colorado		2						31	3	2	12	31		2	102	11
Connecticut										2	2	2			2	
Florida						7				7	7	7	1		79	12
Georgia					1					7	1	8	1	3	74	9
Idaho		6	6			2	33	104	3	205	88	271	152	122	2,459	62
Illinois					6	3		31	1	2	8	34	3	3	53	
Indiana					6			7		1	7	7	7	1	5	
Iowa														21		
Kansas											8	21	11	3	34	
Kentucky					20					9	9	19			187	
Maine								19				19	3	2		
Maryland					2				5	1	1	19			86	1
Massachusetts	2							19				1				
Michigan										4		1	1	1	3	8
Minnesota					4			6				13	2	3	13	
Mississippi																
Missouri																
Montana					1	2		58		21	24	68	2		305	3
Nevada		2	2				33	41		3		81	11	4	388	4
New Hampshire								15			8	15		3	380	2
New Jersey				1				16		12	12	17			42	6
New York					1	1		39	9	6	16	39	3		291	17
North Carolina					1			83	1	48	50	83	11	4	373	5
Ohio					16			14	14	16	44	51	11	4	230	6
Oklahoma					5	3		96	14	6	27	98	7	1	339	10
Oregon										2	2	20	2	1		
Pennsylvania			1	1	8			94	25	54	89	94	14	8	492	40
South Carolina								2		7	2	2			45	1
South Dakota																
Tennessee	8				56			59		10	71	59	3	5	435	17
Texas						11		97	13	13	13	108	8	4	912	278
Utah		4					1	56	1	16	22	56	2		122	16
Vermont								2		7	7	7	2		10	19
Virginia								58		2	14	58	3	2	211	40
Washington			2	4	2			50	20	35	49	66	8	4	341	42
West Virginia					3			8		9	9	21	6		6	3
Wisconsin					1			38		11	12	38	2		113	4
Wyoming		5				1		30		5	5	45	10	4	119	15
Hawaii							7			26	26	35	8	1	497	1,489
	10	20	31	14	145	34	81	1,478	188	698	970	1,890	830	249	12,830	2,529

Alabama.—Plans were made for a systematic survey of the ground-water resources of Alabama in cooperation with the State Geological Survey. Field work is to begin about July 1, 1928.

Arkansas.—At the request of representatives of the rice-growing industry, Mr. Meinzer made a preliminary field study in September, 1927, of the ground-water supply that is used for the irrigation of rice in the area about Stuttgart, Ark., and arrangements were made with the State Geological Survey for an intensive study of this area. The water levels in 16 selected wells were measured in September, 1927, and in April, 1928.

California.—Water levels were measured in selected wells in southern California under the direction of F. C. Ebert. The record now covers a period of 4 years. Work was actively continued on an investigation of the ground water in the alluvial fan of Mokelumne River by H. T. Stearns, T. W. Robinson, J. S. Barnes, and G. H. Taylor. This investigation receives financial support from the East Bay Municipal Utility District. A report on the probable future stages of Salton Sink was completed in manuscript and opened to public inspection.

Colorado.—The report on the utilization of Colorado River in Colorado and Utah to the mouth of Green River was revised preparatory to its publication as a water-supply paper.

Idaho.—A comprehensive investigation of the ground-water conditions in the Snake River Plains and of the relation of the ground-water supply in this region to losses from Snake River and other streams and to the flow of the arge springs in the Snake River Canyon was begun by H. T. Stearns and Lynn Randall. This investigation is being made in cooperation with the Idaho Bureau of Mines and Geology and the Idaho Bureau of Reclamation. Geologic examinations of certain reservoir sites in southeastern Idaho were also made by Mr. Stearns.

Montana.—A study of ground-water levels in an area north of Flathead Lake, Mont., in relation to fluctuations in the lake level was begun by A. H. Tuttle.

New Jersey.—The investigation of the quantities of ground water available in different parts of New Jersey was continued during the year in cooperation with the State Department of Conservation and Development. A report on the Camden area was completed by D. G. Thompson, and progress was made by him in a report on the Passaic area. Observations were continued at two experiment stations and on numerous observation wells. This work was placed in charge of H. C. Barksdale, of the State Department of Conservation and Development.

New Mexico.—The investigation of the Roswell artesian basin, N. Mex., was continued by A. G. Fiedler and S. S. Nye, with financial support from the State Department of Engineering and from Chaves and Eddy Counties. The field work on this project was completed, and much progress was made in the preparation of the report. An investigation of the quantity of ground water available for irrigation in the Mimbres Valley was begun in cooperation with the New Mexico Department of Engineering. A preliminary field study was made by Mr. Fiedler, who prepared a report that was transmitted to the State engineer. A geologic examination of the reservoir of the Zuni Dam on the Zuni Indian Reservation was made by Kirk Bryan for the Office of Indian Affairs. A supplemental report on the Avalon Reservoir of the Carlsbad Irrigation project was prepared by Mr. Bryan and transmitted to the Bureau of Reclamation. A report on the geology and ground-water resources of western Sandoval County was nearly completed by B. C. Renick.

North Carolina.—An investigation of the salt-water problem of the public supply for New Bern, N. C., was made by W. N. White, who prepared a report with recommendations which was transmitted to the city authorities.

Oregon.—Reports were prepared by H. T. Stearns on the geology and water resources of the middle Deschutes Basin and the upper McKenzie Basin, Oreg. Both reports are to be published as contributions to hydrology. A reconnaissance was made by O. E. Meinzer in the Willamette Valley, and arrangements were completed with the agricultural experiment station of the Oregon Agricultural College for making a comprehensive study of the ground-water supplies available for irrigation in this valley.

Pennsylvania.—The reports on ground water in southeastern Pennsylvania, by G. M. Hall, and in southwestern Pennsylvania, by A. M. Piper, were nearly completed, and similar work was begun by R. M. Leggette in the northwestern part of the State. All the ground-water work in Pennsylvania is conducted in cooperation with the State geologist.

Rhode Island.—A report on the geology and ground water of Rhode Island was prepared by C. W. Brown, superintendent of the Natural Resources Survey of Rhode Island. This report is to be combined with a report on the chemical character of the waters of the State by W. D. Collins and Margaret D. Foster.

South Carolina.—Some progress was made on a report on the geology and ground-water conditions of the Coastal Plain of South Carolina by C. W. Cooke, of the geologic branch.

Tennessee.—A systematic survey of the ground waters of Tennessee was undertaken in cooperation with the State Geological Survey. Field work was completed in 12 counties in north-central Tennessee by A. M. Piper, and similar work was begun in the southwestern part of the State by F. G. Wells. Ebbing and flowing springs near Rogersville and Lenoir City were examined by G. M. Hall, who presented a paper on the subject before the Tennessee Academy of Sciences.

Texas.—A report on ground-water conditions in the vicinity of Amarillo, Tex., by S. S. Nye, was transmitted to the Bureau of Mines. Field work was also done by Mr. Nye on ground-water conditions in 12 counties in the Nueces area of the Coastal Plain, in parts of which considerable land is being brought under irrigation by means of water derived from wells.

Utah.—Field work on the intensive study of ground-water discharge in Escalante Valley, Utah, was completed by W. N. White, and a report on the results of this investigation is being prepared. The report on the utilization of Green River, in Wyoming, Colorado, and Utah, was completed and will be published as a water-supply paper.

Virginia.—Weekly measurements of the water level in the observation well in Arlington County, Va., were continued during the first part of the year, but later a water-stage recorder was installed over the well in order to obtain a continuous record of the fluctuations of the water table. The ground-water conditions in the vicinity of Manassas were examined by O. E. Meinzer, and a brief report with recommendations by him was transmitted to the city authorities. A water-stage recorder was installed over an ebbing and flowing spring (known as the Tide Spring), near Broadway, and a continuous record of the performance of this spring for nearly a year was obtained. An intensive study of the thermal springs of the State was begun, and several months were spent in field work by Frank Reeves, of the geologic branch, and R. P. Meacham, of the State Geological Survey, on a survey of the springs of the western part of the State with special reference to their temperature. The investigations of the ebbing and flowing spring and of the thermal springs of the State are carried on in cooperation with the State geologist.

Washington.—Work has been continued on river surveys and power investigations of streams draining the Olympic Range, Wash.

CONSERVATION BRANCH

HERMAN STABLER, *Chf*

The work of the conservation branch, comprising the classification of public lands with respect to mineral, water-power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands increased materially during the fiscal year 1928. It was directed in that year through four administrative divisions as follows:

Mineral classification division, J. D. Northrop, senior geologist, in charge.

Power division, B. E. Jones, hydraulic engineer, in charge.

Agricultural division, J. F. Deeds, hydraulic engineer, in charge.

Mineral leasing division, H. I. Smith, chief mining supervisor, in charge.

PERSONNEL

Personnel changes during the fiscal year include 15 separations (12 ignations, 2 deaths, and 1 transfer) and 18 additions. On June 1928, the personnel of the branch, both office and field, numbered 1, consisting of 83 professional and subprofessional and 59 clerical ployees. Of these, 3 were on detail the entire year to the Federal wer Commission.

FUNDS

The funds appropriated or transferred for the work of the con- vation branch in the fiscal year were as follows:

Classification of lands.....	\$200,000
Supervision of leasing operations.....	288,500
Supervision of naval reserve operations.....	58,700
Repay, Federal Power Commission.....	2,592
	<hr/>
	549,792

This aggregate is about \$35,000 less than in 1927 and about \$72,000 s than in 1926. With annually diminishing funds and annually reasing demands for service the task of affording even reasonable otection of the public interest in its natural resources, undeveloped l under development, is increasingly difficult.

CORRESPONDENCE

During the year 35,076 letters were received in the Washington ce, an increase of 10,906, or 45 per cent, over 1927. About 36,800 ces of miscellaneous correspondence were also received for infor- tion, for reference to the appropriate field office, or for filing. thin the same period 27,152 letters were answered, an increase of 00, or nearly 46 per cent, and about 13,600 additional pieces of scellaneous correspondence were sent out.

SUMMARY OF LAND-CLASSIFICATION CASES

The activities of the conservation branch with respect to land ssification include the preparation of reports in response to re- sts for data or action on specific cases, the preparation of orders withdrawal and restoration of lands not involved in specific uests, and the promulgation of broad areal classifications. The llowing table summarizes activity with respect to requests for ta or action on specific cases, and the terms "gain" and "loss" nify, respectively, decrease and increase in the number of cases nding. In spite of strenuous effort and the voluntary overtime ork of an efficient personnel the number of cases pending was reater by 685, or 20 per cent, at the end of the year than at its nning

General summary of cases involving land classification

Class of cases	Record for fiscal year 1927-28						Record since receipt of first case	
	Pending July 1, 1927	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1928	Gain or loss during fiscal year	Received	Acted on
General Land Office requests:								
General.....	480	950	1,430	1,086	344	+136		
Time extensions.....	47	676	723	682	41	+6	1,677	1,68
Oil development.....	585	9,613	10,198	8,591	1,607	-1,022	12,856	11,351
Application for classification as to mineral:								
General.....	1	4	5	4	1		10	9
Coal.....	5	4	9	6	3	+2	777	774
Oil.....	156	543	699	601	98	+58	6,706	6,685
Phosphate.....		2	2	2			37	37
Applications for mineral permits.....	1,003	4,722	5,725	5,342	383	+620	48,757	48,574
Applications for mineral leases.....	18	114	132	120	12	+6	1,230	1,218
Applications for patent, potassium.....		1	1		1	-1	124	123
Federal Power Commission cases:								
Preliminary permits.....	6	10	16	6	10	-4	69	59
Licenses.....	10	2	12	12		+10	24	34
Determinations under sec. 24.....	5	40	45	37	8	-3	198	199
Applications for reclassification as to water resources.....	7	33	40	22	18	-11	711	690
Applications for rights of way.....	33	149	182	151	31	+2	6,069	6,066
Irrigation project reports.....	5	11	16	12	4	+1	909	905
Applications under enlarged homestead acts.....	243	345	588	374	214	+29	56,412	56,198
Applications under stock-raising homestead acts.....	1,171	3,395	4,566	2,862	1,704	-533	121,940	120,236
Applications under ground-water reclamation act.....	27	15	42	34	8	+19	878	859
Indian Office requests for information.....							9,305	9,306
Cases in national forests.....	1	12	13	12	1		324	323
	3,803	20,641	24,444	19,956	4,488	-685		

SUMMARY OF FIELD OPERATIONS BY STATES

Alaska.—Expended \$14,500 through the Alaskan branch for supervision of 9 coal leases, 7 coal prospecting permits, and 1,028 oil and gas prospecting permits. Coal produced, 106,382.66 tons; accrued rent and royalty, \$19,495.19.

Alabama.—Supervised 1 coal lease and 4 oil and gas prospecting permits. Coal produced, 43,523 tons; accrued rent and royalty, \$4,352.30.

Arizona.—Examined 20 tracts for agricultural classification. Investigated a reported occurrence of sodium near Camp Verde, Yavapai County. Supervised 7 coal prospecting permits, 5 sodium permits, 28 potassium permits, and 568 oil and gas permits. Reported on metalliferous leases and lease applications involving lands in three Indian reservations and on a coal supply for agency use on four reservations.

Arkansas.—Supervised 1 coal prospecting permit and 13 oil and gas permits.

California.—Investigated oil and gas development in the Poso Creek and Round Mountain districts, Kern County. Examined 48 tracts for agricultural classification. Supervised 125 oil and gas leases, 2,087 oil and gas prospecting permits, 6 coal permits, 4 sodium permits, 4 potassium leases, and 1 potassium permit, involving public lands. Oil produced, 6,834,749 barrels; natural gas, 568,656,000 cubic feet; natural-gas gasoline, 4,139,839.32 gallons; coal, 3 tons; sodium borate, 3,809.90 tons; sodium carbonate, 6,051.30 tons. Total rent and royalty accrued, \$684,050.49. Supervised 26 oil and gas leases on Naval Petroleum Reserves Nos. 1 and 2. Oil produced, 9,690,573.93 barrels; natural gas, 9,077,967,000 cubic feet; natural-gas gasoline, 24,797,264 gallons. Total rent and royalty accrued, \$2,198,412.07.

Colorado.—Examined 5 tracts in Las Animas County for oil and gas classification and 1 tract in La Plata County for coal classification. Made structural reconnaissance of 30 townships in Bent, Prowers, and Las Animas Counties. Investigated geologic structure of lands adjacent to Whiskey Creek oil seep, in Garfield County. Examined 40 tracts for agricultural classification and made

gional investigations of agricultural utility precedent to broad areal classification in the eastern and northwestern parts of the State. Supervised 12 oil and gas leases, 68 coal leases, 7 coal licenses, 3,129 oil and gas prospecting permits, 32 coal permits, and 19 potassium permits. Oil produced, 921,641 barrels; natural gas, 14,360,000 cubic feet; natural-gas gasoline, 93,465 gallons; coal, 9,650.40 tons. Total rents and royalties accrued, \$102,707.44.

Florida.—Examined 1 area in Alachua County and 2 areas in Citrus County for phosphate classification.

Idaho.—Investigated power resources of North, Middle, and South Forks Boise River and geologic conditions affecting one dam site on the South Fork. Examined 53 tracts for agricultural classification. Supervised 2 phosphate leases, 247 oil and gas prospecting permits, 4 coal permits, and 2 sodium permits. Phosphate rock produced, 23,459.95 tons. Accrued rents and royalties, \$529.85.

Kansas.—Made regional investigations in western Kansas precedent to broad areal classification as to agricultural utility. Supervised 6 oil and gas prospecting permits.

Louisiana.—Investigated the status of oil and gas development in the Cross Lake district, Caddo Parish. Supervised 6 oil and gas leases and 50 prospecting permits. Oil produced, 9,509 barrels; natural gas, 339,308,000 cubic feet; natural-gas gasoline, 74,535 gallons. Total rents and royalties accrued, \$3,829.21.

Michigan.—Supervised 1 oil and gas prospecting permit.

Mississippi.—Supervised 3 oil and gas prospecting permits.

Montana.—Examined through the geologic branch 6 townships in Powder River County and 14 townships in McCone County, for coal classification, and terminated the geologic conditions affecting one dam site on the South Fork Flathead River. Examined 83 tracts for agricultural classification. Supervised 47 oil and gas leases, 51 coal leases, 11 coal licenses, 1,855 oil and gas prospecting permits, and 17 coal permits involving public lands. Oil produced, 8,286 barrels; natural gas, 193,824 cubic feet; coal, 278,886.33 tons. Total rent and royalty accrued, \$107,964.87. On behalf of the Office of Indian Affairs, exercised supervision over 49 oil and gas leases involving tribal and restricted lands of the Blackfeet and Crow Indians, and examined land sought under a silver lease on the Rocky Boy Indian Reservation.

Nebraska.—Examined 10 tracts for agricultural classification and made regional investigations in western Nebraska to afford basis for broad areal classification as to agricultural utility. Supervised 4 oil and gas-prospecting permits.

Nevada.—Examined 40 tracts for agricultural classification. Supervised 1 sodium lease, 506 oil and gas-prospecting permits, 3 coal permits, and 8 sodium permits. Sodium sulphate produced 750 tons, coal produced 91.15 tons. Total rents and royalties accrued, \$1,462.79.

New Mexico.—Examined 41 tracts in Guadalupe, Quay, Curry, Roosevelt, De Baca, Chaves, Eddy, Lea, Valencia, San Juan, and Rio Arriba Counties for oil and gas classification. Made geologic examination and published structural map of the Artesia oil field, Eddy County. Began geologic examination through the geologic branch of McKinley and Sandoval Counties for coal classification. Supervised 13 coal leases, 6 oil and gas leases, 4,286 oil and gas-prospecting permits, 59 coal permits, 71 potassium permits, and 2 sodium permits, involving public lands. Coal produced 74,462.82 tons, oil 72,384 barrels, natural gas (volume not measured), natural-gas gasoline 6,991 gallons. Total rents and royalties accrued \$25,456.39. On behalf of the Office of Indian Affairs, exercised supervision over 60 oil and gas leases, involving tribal and allotted lands of the Navajo Indians, and rendered advisory service in connection with the leasing of all lands or with obtaining coal for school and agency use on four Indian reservations.

North Dakota.—Examined 7 tracts for agricultural classification. Supervised 2 coal leases, 2 coal licenses, 5 coal-prospecting permits, and 29 oil and gas-prospecting permits. Coal produced 404,456.71 tons, or 22 per cent of the entire coal production of the State. Total rent and royalty accrued, \$30,323.88.

Oklahoma.—Continued, in cooperation with the Oklahoma Geological Survey, the geologic examination of segregated Choctaw and Chickasaw coal lands begun in 1927. Supervised on public lands 18 oil and gas leases involving lands in the bed of Red River, Tillman County, and 85 oil and gas-prospecting permits. Oil produced 602,165 barrels; natural-gas gasoline, 1,298,568 gallons; coal rents and royalties accrued, \$147,974.25. Supervised on Indian lands 515 oil and gas leases involving 929,753 acres and 5,731 producing wells; accrued rents and royalties, \$6,140,090.76. Supervised on segregated lands of

the Choctaw and Chickasaw Nations 78 coal leases and 1 asphalt lease, on restricted allotted lands of the Cherokee Nation 10 coal leases and 1 lead and zinc lease, on restricted allotted lands of the Creek Nation 43 coal leases and 1 volcanic-ash lease, and on restricted allotted lands of the Choctaw Nation 10 coal leases; total area under supervision, 399,428 acres; coal produced, 654,920.87 tons from 67 leaseholds. Supervised on restricted Quapaw lands, 55 lead and zinc leases involving 7,284 acres and 49 subleases involving 2,374 acres; concentrates produced, 215,993 tons; sale value \$9,425,525.78, accrued royalty \$894,820.30.

Oregon.—Investigated power resources on Umpqua and Molalla Rivers. Examined 40 tracts for agricultural classification. Supervised 2 coal leases, 1 oil-shale lease, 50 oil and gas-prospecting permits, 1 coal permit, and 1 potassium permit. Coal produced, 1,280.03 tons. Accrued rents and royalties, \$948.

South Dakota.—Examined 16 tracts for agricultural classification. Supervised 1 coal lease and 118 oil and gas-prospecting permits. Coal produced, 422.68 tons; accrued rent and royalty \$43.32.

Utah.—Investigated power resources on Provo River. Examined one tract in Uintah County for asphalt classification and another in the same county for coal classification. Continued through the geologic branch broad areal investigation of stratigraphy and structure in Grand and San Juan Counties for oil and gas classification. Began geologic investigations in Cache County for phosphate classification. Examined 64 widely scattered tracts for agricultural classification. Supervised 43 coal leases, 2 coal licenses, 4 oil and gas leases, 3,289 oil and gas prospecting permits, 21 coal permits, 17 potassium permits, and 3 sodium permits. Coal produced, 432,708 tons; petroleum, 2,255 barrels; natural gas, 1,064,726,000 cubic feet. Total rents and royalties accrued, \$78,719.70.

Washington.—Investigated power resources on Elwha, Quinault, Hoh, and Soleduck Rivers and geologic conditions affecting two dam sites on Columbia River. Examined 5 tracts for agricultural classification. Supervised 1 coal lease, 9 coal prospecting permits, 74 oil and gas permits, and 1 sodium permit. Coal produced, 33,724 tons. Accrued rents and royalties, \$3,495.22.

West Virginia.—Provided technical testimony on behalf of the State in the prosecution and conviction of A. D. Williams and E. D. Fry for violation of the West Virginia speculative securities act in the circuit court for Pocahontas County, and on behalf of the Federal Government in the indictment, prosecution, and conviction of the same defendants for using the mails to defraud, in the District Court of the United States for the Southern District of West Virginia at Charleston; these actions resulting from sales of stock involving an oil and gas prospecting permit in Natrona County, Wyo.

Wyoming.—Examined lands in Lincoln County for phosphate classification and lands in Sublette, Teton, Big Horn, and Converse Counties for oil and gas classification. Examined 55 widely scattered tracts for agricultural classification. Supervised on public lands 299 oil and gas leases, 35 coal leases, 5 coal licenses, 4,285 oil and gas prospecting permits, 15 coal permits, and 1 sodium permit. Petroleum produced, 14,659,561 barrels; natural gas, 16,741,152,000 cubic feet; natural-gas gasoline, 34,084,894 gallons; coal, 1,184,658 tons; total rents and royalties accrued, \$2,909,405.61. Supervised 57 productive wells on naval petroleum reserve No. 3, which produced 149,285 barrels of petroleum, 795,854,000 cubic feet of natural gas, and 743,179 gallons of natural-gas gasoline, the aggregate royalty value of which was \$33,963.32. Supervised on tribal and allotted restricted lands of the Shoshone Indians, 74 oil and gas leases.

MINERAL-CLASSIFICATION DIVISION

The work of the mineral-classification division involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, chiefly through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation. The results of its work take the form of mineral classifications, of orders of withdrawal, modification, and restoration, and of reports concerning the mineral

Character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public-land and Indian-land laws.

Little progress was made in 1928 in classifying the vast areas throughout the West that are still embraced in mineral withdrawals. The results accomplished include, however, net decreases of 720 acres in the total area of outstanding coal withdrawals, of 3,960 acres in the total area of outstanding petroleum withdrawals, and of 13,276 acres in the total area of outstanding phosphate reserves.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications, June 30, 1928, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash
	Withdrawn	Classified as coal land	Withdrawn	Classified as oil land	Withdrawn	Classified as oil-shale land	Withdrawn	Classified as phosphate land	Withdrawn
Alaska		56,993							
Arizona	139,415		92,496						
Arkansas		61,160							
California	17,603	8,720	1,178,392						90,357
Colorado	4,180,016	3,145,867	218,997		64,560	952,239			
Florida							68,506	120	
Idaho	4,761	4,603					391,532	263,299	
Louisiana			466,990	4,233					
Montana	7,883,164	8,660,671	1,350,426	67,651			279,944	3,833	
Nevada	83,673				123				39,422
New Mexico	5,084,069	570,372							7,418,437
North Dakota	5,954,364	11,178,286	84,894						
Oregon	4,361	18,887							
South Dakota		250,063							
Texas	3,636,541	1,267,697	1,341,264		91,464	2,703,755	301,945	100	
Washington	691,801	141,444							
Wyoming	2,260,604	6,738,516	541,777			460,103	980,289	25,293	
	29,940,372	32,003,309	5,275,236	71,884	156,147	4,116,097	2,031,306	297,705	7,548,216

The functions of this division in connection with administration of the mineral leasing laws, fully described in earlier reports, were materially increased in 1928 by reason of an intensive campaign in the General Land Office to cancel oil and gas prospecting permits the terms of which had had no compliance. This action is predicated on reports from the Geological Survey showing that the physical condition of each permit holding interposes no bar and that no test well competent to establish the oil or nonoil character of the land is being drilled elsewhere within the limits of the geologic structural feature involved. Requests for reports of this type numbered 9,613 in 1928, compared with 1,428 in 1927, and more than 1,000 were awaiting response on June 30, 1928.

The following table summarizes the year's work to the extent that it involves technical reports on original applications for permit or lease rights under the leasing laws. One application for patent under the potassium law of October 2, 1917, was received during the year and was pending at its end.

*Applications received, acted on, and pending under the mineral-leasing act,
fiscal year 1928*

Mineral	Permits			Leases		
	Received	Acted on	Pending	Received	Acted on	Pending
Oil and gas.....	4,434	5,025	377	1	3	-----
Coal.....	164	189	6	99	100	9
Phosphate.....	-----	-----	-----	4	9	1
Sodium.....	12	12	-----	1	1	-----
Potassium.....	112	116	-----	5	3	2
Oil shale.....	-----	-----	-----	-----	-----	-----
Sulphur.....	-----	-----	-----	4	4	-----

In furtherance of the task delegated to the Geological Survey by section 2 of the departmental regulations pertaining to oil and gas leases and prospecting permits, definitions of the "known geological structure" of the following producing fields were prepared and promulgated during the year:

Ashley Creek, Utah; 1,240 acres; promulgated October 14, 1927.

Lost Soldier, Wyo.; 960 acres; promulgated July 28, 1927.

South Sunshine, Wyo.; 2,702 acres; promulgated August 4, 1927.

The net area included in outstanding definitions of the "known geological structure" of producing oil and gas fields on June 30, 1928, was 517,745 acres, in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Geologic field work required in the solution of the problems of this division is performed in part by summer detail of Washington employees, in part by a division geologist with permanent headquarters in Denver, Colo., and in part by the geologic branch at the expense of the conservation branch. The work accomplished in 1928 is included in the branch summary of field operations by States beginning on page 52.

POWER DIVISION

The work of the power division consists primarily in obtaining and making available for use in the administration of the public land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public land laws. An endeavor is made to determine the proper administrative action by which the possibility of power development may be preserved with minimum interference with agricultural, transportation, or other interests. In the course of this work a review of all power reserves is carried on in order that all land having primary value for the development of power, and only such land, shall be reserved for that purpose. The extent of this task is indicated by the fact that areas aggregating more than 6,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches of the Geological Survey. The field projects undertaken during the year to obtain information for power classification, including plan and profile surveys, power-site and reservoir-site investigations, and geologic studies of dam sites, are included in the branch summary of field operations (pp. 52-54).

The information obtained in the field is indexed and incorporated in an inventory of water resources which, when complete, will enable the Geological Survey to give competent advice on short notice as to the manner in which each tract of public land having value for power can best be used in connection with the development of water power and as to the relation of such use to other possible uses of the land. Copies of many of the reports on the power possibilities of the lands examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press.

The work of the division is briefly summarized in the accompanying tables showing power-site reserves and outstanding water-resources withdrawals and classifications and in the general summary of uses involving land classification (p. 52).

Pursuant to instructions of the Secretary of the Interior dated August 24, 1916 (45 L. D. 326), permittees under the act of February 29, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (Stat. 1253), to whom rights have been granted by the Secretary on January 1, 1913, were called upon for detailed reports of the operation or development of their power systems during the calendar year 1927. The total installation of the reporting companies is 1,000 kilowatts, of which 2,024,000 kilowatts is installed at hydraulic plants. The total energy generated was 8,116,000,000 kilowatt-hours, of which more than 7,546,000,000 kilowatt-hours was rated by water power. That generated by steam has decreased 100,000 kilowatt-hours, but the energy generated by water power increased 1,026,000,000 kilowatt-hours, making the net increase 926,000,000 kilowatt-hours.

Power output of permittees and grantees, 1916-1927

	Kilowatt-hours	Increase or decrease		Year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1,200,000,000				1922	4,947,000,000	+1,222,000,000	+33
2,000,000,000	+800,000,000	+67		1923	5,910,000,000	+963,000,000	+19
3,200,000,000	+1,200,000,000	+60		1924	6,100,000,000	+194,000,000	+3
3,100,000,000	-100,000,000	-3		1925	6,930,000,000	+830,000,000	+14
4,300,000,000	+1,200,000,000	+35		1926	7,800,000,000	+870,000,000	+13
3,725,000,000	-475,000,000	-11		1927	8,116,000,000	+316,000,000	+4

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat., 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1927	Eliminated prior to July 1, 1927	Reserves outstanding prior to July 1, 1927	Reserved during fiscal year	Eliminated during fiscal year	Reserve outstanding June 30, 1928
Alabama.....	2,377		2,377			127
Alaska.....	218,177	520	217,657	28,889		246,546
Arizona.....	1,275,681	124,010	1,151,671	7,295	2	1,158,964
Arkansas.....	29,671		29,671		360	29,311
California.....	1,315,213	30,243	1,284,970	52,823		1,337,793
Colorado.....	531,273	75,783	455,490	6,247	1,237	460,500
Florida.....	1,019		1,019	112		1,131
Idaho.....	590,545	191,521	399,024	15,097	13	414,108
Michigan.....	1,240		1,240			1,240
Minnesota.....	19,062	532	18,530			18,530
Mississippi.....	3		3			3
Montana.....	303,766	96,379	207,387	723		208,110
Nebraska.....	761		761			761
Nevada.....	301,196	490	300,716			300,716
New Mexico.....	270,878	10,511	260,367			260,367
Oregon.....	753,183	112,248	640,935	16,021	11,715	645,241
South Dakota.....	52		52	584		636
Utah.....	756,709	126,398	630,311	15,224	120	645,415
Washington.....	392,759	53,835	338,924	5,256		344,180
Wisconsin.....	1,853	226	1,627	13		1,640
Wyoming.....	222,622	75,346	147,276	9,855	938	156,193
	6,988,040	898,032	6,090,008	158,139	14,385	6,233,762

*Summary of outstanding water resources, withdrawals, and classifications
June 30, 1928, in acres*

State	Power reserves					Reservoir withdrawals	Public-water reserves
	Withdrawals	Classifications	Designations*	Miscellaneous	Total		
Alabama.....	120	1,735		522	2,377		
Alaska.....	93,415	70,825		82,306	246,546		
Arizona.....	386,259	37,182	528,237	207,286	1,158,964	23,040	20,138
Arkansas.....	21,994	1,590		5,727	29,311		
California.....	287,391	322,129		728,273	1,337,793	1,100	198,796
Colorado.....	230,673	175,770		54,057	460,500	1,728	4,898
Florida.....				1,131	1,131		
Idaho.....	205,637	195,117		13,354	414,108		13,965
Michigan.....	1,240				1,240		
Minnesota.....	12,309			6,221	18,530		
Mississippi.....				3	3		
Montana.....	129,944	53,452		24,714	208,110	9,080	8,857
Nebraska.....	761				761		
Nevada.....	27,492	28,026		245,198	300,716		11,176
New Mexico.....	117,206		143,161		260,367		9,881
North Dakota.....						1,569	
Oregon.....	361,063	203,872	15,250	65,056	645,241	10,619	21,361
South Dakota.....				636	636		340
Utah.....	412,375	168,943		34,097	645,415	80	33,690
Washington.....	97,086	180,691		66,403	344,180	35,943	929
Wisconsin.....				1,640	1,640		
Wyoming.....	79,953	35,407		40,833	154,193	1,714	78,433
	2,494,918	1,474,739	686,648	1,577,457	6,233,762	84,933	403,361

* Designated and not otherwise withdrawn.

AGRICULTURAL DIVISION

The functions of the agricultural division consist of the classification of lands under the enlarged homestead law as nonirrigable; the classification of lands under the Nevada ground-water reclamation law as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; and the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family.

Applications for classification are disposed of in accordance with the results of field examinations by members of the division and with information obtained from other sources. Applications in some regions lead to the planning and execution of broad field studies that result in the classification of large areas and provide in advance the basis for appropriate action on new applications.

The number of cases received and acted on during the fiscal year by the agricultural division is shown in the general summary of cases (p. 52). It increased about 12 per cent above the number received in 1927 and resulted in an arrearage 33 per cent greater at the end of 1928 than at the end of 1927.

In the field broad areal studies were continued in the central Great Plains region in Colorado, Kansas, Nebraska, and Wyoming and were begun in the Colorado Basin region in northwestern Colorado and southwestern Wyoming.

The first of a series of maps showing the agricultural utility of the central Great Plains was published, together with a brief text discussing the agricultural characteristics of each of its several parts. This series of maps is uniform with the series of eight relating to the northern Great Plains prepared in cooperation with the Department of Agriculture in 1927 and published in a preliminary edition in that year.

During the fiscal year 1928 the area designated under the Nevada ground-water reclamation act as a result of the work of the division was increased 42,920 acres, to a total of 1,619,215 acres. Outstanding withdrawals, aggregating 11,530 acres, under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

Summary of enlarged-homestead designations, in acres

[Areas classified as arid and nonirrigable, residence by entrymen required (act of Feb. 19, 1909 (35 Stat., 630), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat., 531), applicable to Idaho; act of June 13, 1912 (37 Stat., 137), applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat., 953), applicable to Kansas; act of Mar. 4, 1915 (38 Stat., 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (act of Feb. 19, 1909 (35 Stat., 630), applicable to Utah; act of June 17, 1910 (36 Stat., 531), applicable to Idaho)]

State	Designations prior to July 1, 1927	Cancellations prior to July 1, 1927	Designations outstanding prior to July 1, 1927	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1928
Arizona.....	31,431,179	5,870,874	25,560,305	71,405		25,631,710
California.....	13,277,544	238,453	13,039,091	55,682	2,000	13,092,773
Colorado.....	33,718,793	195,506	33,523,285	91,824		33,615,119
Idaho:						
Total.....	13,690,819	460,925	13,229,894	63,371	* 440	13,292,825
Nonresidence.....	572,747	4,233	568,514	480		568,994
Kansas.....	650,404		650,404	960		651,364
Montana.....	53,457,850	245,728	53,212,122	27,800		53,239,922
Nevada.....	50,168,165	3,580,717	46,587,448			46,587,448
New Mexico.....	43,772,180	227,732	43,544,448	65,177		43,609,625
North Dakota.....	12,277,704	3,848	12,273,856	3,000		12,276,856
Oregon.....	21,276,707	989,802	20,286,905	5,604		20,292,469
South Dakota.....	16,336,096	348,170	15,987,926	4,665		15,992,591
Utah:						
Total.....	11,651,754	700,084	10,951,670	3,022	* 1,400	10,953,292
Nonresidence.....	1,647,889	81,560	1,566,329	3,022	320	1,569,081
Washington.....	6,655,192	251,842	6,403,350	5,260		6,408,610
Wyoming.....	29,594,332	162,043	29,432,289	82,960		29,515,249
	337,958,719	13,275,826	324,682,893	480,740	3,840	325,159,793

* Previously designated under secs. 1-5, now designated under sec. 6.

† Includes 1,080 acres previously designated under secs. 1-5, now designated under sec. 6.

Summary of stock-raising homestead designations, in acres

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family. Act of December 29, 1916 (39 Stat. 862)]

State	Designations prior to July 1, 1927	Cancellations prior to July 1, 1927	Designations outstanding prior to July 1, 1927	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1928
Arizona.....	13,988,504	887,580	13,100,924	68,162		13,169,086
Arkansas.....	1,120		1,120			1,120
California.....	7,888,299	1,400	7,886,899	77,605	2,000	7,962,504
Colorado.....	8,511,501	18,840	8,492,661	136,077	80	8,628,636
Florida.....	480	480				
Idaho.....	5,449,617	1,854	5,447,763	95,674		5,543,437
Kansas.....	114,139		114,139	1,000		115,139
Michigan.....	3,451		3,451	40		3,491
Montana.....	15,349,734	17,081	15,332,653	137,389		15,470,042
Nebraska.....	194,809		194,809	7,375		202,184
Nevada.....	566,094	3,120	562,974	19,995		582,969
New Mexico.....	31,284,608	636	31,283,972	79,345		31,363,317
North Dakota.....	375,892		375,892	7,808		383,700
Oklahoma.....	82,082		82,082	1,528		83,610
Oregon.....	6,310,759	3,128	6,307,631	44,619		6,352,250
South Dakota.....	6,496,538	550	6,495,988	13,510		6,509,498
Utah.....	1,651,770	6,520	1,645,250	144,379	1,280	1,788,349
Washington.....	690,161	1,134	689,027	4,525	40	693,512
Wyoming.....	20,089,648	6,213	20,083,435	188,463	160	20,271,738
	119,049,206	948,536	118,100,670	1,027,494	3,560	119,124,604

By blanket order of withdrawal creating public water reserve No. 107, which received Executive approval April 17, 1926, every smallest legal subdivision of the public-land surveys which is vacant unappropriated public land and contains a spring or water hole and all land within a quarter of a mile of every spring or water hole located on unsurveyed public land was reserved for public use and in aid of pending legislation. This order obviated the necessity for future withdrawals of specific tracts containing springs or water holes valuable for stock watering but requires a determination by the division with respect to all entries of public land, whether or not any of the subdivisions involved are in fact affected by it. On the basis of such determination orders of interpretation are issued from time to time listing by legal subdivisions of the public-land survey any tracts found to contain a water supply affected by the order. New withdrawals of this type are made to reserve lands along streams and are also made from time to time for special public purposes. The extent of outstanding reserves of this type and of current action affecting them is shown in the following table:

Public-water reserves, in acres

Includes areas withdrawn under the act of June 25, 1910 (41 Stat., 1063), as amended by the act of Aug. 24, 1912 (37 Stat., 497), and reserved for public use of springs or water holes in accordance with the provisions of sec. 10 of the act of Dec. 29, 1916 (39 Stat., 862), or for watershed protection, drainage reservoirs, or other similar miscellaneous public purposes involving water conservation]

State	Reserved prior to July 1, 1927	Eliminated prior to July 1, 1927	Reserves outstanding prior to July 1, 1927	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1928
Arizona.....	19,177	1,602	17,575	2,605	30	20,150
California.....	178,412	7,130	171,282	27,512	8	198,786
Colorado.....	2,660	360	2,300	2,560		4,860
Idaho.....	13,755	410	13,345	560		13,905
Montana.....	9,209	1,152	8,057	800		8,857
Nevada.....	12,506	3,250	9,256	1,920		11,176
New Mexico.....	10,401	520	9,881			9,881
Oregon.....	21,789	1,288	20,501	760		21,261
South Dakota.....	240		240			240
Utah.....	39,791	6,876	32,915	1,735	720	33,930
Washington.....	920		920			920
Wyoming.....	92,605	13,300	79,305	240	120	79,425
	401,465	35,888	365,577	38,692	878	403,391

MINERAL-LEASING DIVISION

The work of the mineral-leasing division is supervisory (both inspectional and regulatory) with respect to operations for the discovery and development of petroleum, natural gas, oil shale, coal, phosphate, sodium, potassium, and sulphur on public lands; of petroleum and natural gas on naval petroleum reserves; and of a variety of minerals on Indian lands. This work is carried on with a minimum of administrative supervision from Washington through district offices and suboffices at or near the primary centers of mining or drilling activity, under the direction of responsible engineers who have full authority to represent the Government within their jurisdiction and to enforce compliance with the law and regulations under which operations are conducted.

ACTIVITIES ON THE PUBLIC DOMAIN

Supervisory work on lands containing publicly owned mineral deposits was increased during the fiscal year 1928 by the issuance of leases, licenses, and prospecting permits as follows:

	Number	Acres		Number	Acres
Leases:			Permits:		
Oil and gas.....	47	21,945.83	Oil and gas.....	4,406	7,559,993.26
Coal.....	37	9,126.05	Coal.....	83	100,496.61
Licenses:			Potassium.....	85	197,307.83
Coal.....	8	320.00	Sodium.....	14	21,421.00
				4,588	7,879,190.72

During the same period supervisory work was decreased by reason of the cancellation of 5 coal leases, 1 oil and gas lease, 5 coal prospecting permits, 1 sodium permit, 50 potassium permits, and 7,765 oil and gas permits.

The following table shows, by States and by minerals, the total number of prospecting permits, leases, and licenses involving public land under supervision at the end of the fiscal year:

Mineral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey June 30, 1928

State	Coal						Oil and gas	
	Leases		Permits		Licenses		Leases (number)	Permits (number)
	Number	Acres	Number	Acres	Number	Acres		
Alaska.....	9	11,307.28	7	12,115.66				1,028
Alabama.....	1	1,840.00						4
Arizona.....			7	16,560.00				568
Arkansas.....			1	120.00				13
California.....			6	4,478.51			151	2,067
Colorado.....	68	11,907.65	32	20,252.00	7	280.00	12	2,129
Idaho.....			4	5,402.91				247
Kansas.....								6
Louisiana.....							6	150
Michigan.....								1
Mississippi.....								3
Montana.....								1,855
Nebraska.....	50	6,694.21	9	7,600.00	8	319.95	47	4
Nevada.....			3	6,021.88				508
New Mexico.....	13	6,410.38	59	98,660.21			6	4,266
North Dakota.....	41	5,856.44	2	320.46	1	40.00		29
Oklahoma.....								74
Red River.....							18	11
Oregon.....	2	1,895.24	1	40.00				59
South Dakota.....	1	79.04						118
Utah.....	43	33,052.77	21	22,492.64	2	120.00	4	2,286
Washington.....	1	600.00	9	5,862.33				74
Wyoming.....	35	15,982.98	15	11,914.69	5	199.95	299	4,285
	204	95,625.99	176	211,841.20	23	959.99	543	21,726

* Includes 15 leases on naval petroleum reserves Nos. 1 and 2 under the act of Feb. 25, 1920, and 11 on naval petroleum reserves Nos. 1 and 2 under the act of June 4, 1920.

† Oil and gas permits in Louisiana include the right to lease sulphur deposits discovered while prospecting for oil and gas.

Mineral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey June 30, 1928—Contd.

State	Sodium				Potassium			
	Leases		Permits		Leases		Permits	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Arizona.....			5	12,480.00			{ 23	57,440.00
California.....			4	5,115.96	4	7,783.80	{ 5	9,040.00
Colorado.....							{ 1	2,559.58
Idaho.....							{ 18	37,945.00
Nevada.....	1	1,440.00					{ 1	2,538.67
New Mexico.....			2	3,254.11			{ 20	42,960.00
Oregon.....			8	16,661.04			{ 51	120,980.00
Utah.....			2	5,120.00			{ 1	2,560.00
Washington.....			3	3,840.00			{ 17	36,998.68
Wyoming.....			1	1,245.00				
	1	1,440.00	25	47,716.11	4	7,783.80	137	313,001.98

* Act of Feb. 7, 1927.

Also Idaho, 2 phosphate leases, 1,700 acres; Oregon, 1 oil-shale lease, 2,680 acres. Total, 815 leases; 23 licenses; 22,054 permits; grand total 22,892.

The total number of licenses and permits issued by the Secretary of the Interior had been 318 leases, 1,019 permits, and 136 licenses for coal, 18 leases and 648 permits for potash, 1 lease and 80 permits for sodium, 2 leases each for oil shale and phosphate, and 591 leases and 32,256 permits for oil and gas.

PRODUCTION

In the fiscal year 1928 an increase of 487,550 tons, or 19 per cent, was recorded in the production of coal and of 9,914 tons, or 160 per cent, in the production of sodium minerals from public lands, compared with 1927. In the same period a decrease of 2,277,552 barrels, or 8 per cent, was recorded in the production of petroleum and of 394 tons, or about 1.6 per cent, in the production of phosphate rock. Prospecting for potassium minerals was continued with good success in Eddy County, N. Mex., but no potassium salts were produced there nor from public lands under potassium lease in the Searles Lake district, California, or the Salduro district, Utah.

Statistics relating to the production of petroleum, natural gas, natural-gas gasoline, coal, phosphate, and sodium under Government leases, permits, and licenses involving public land are summarized in the following tables:

*Petroleum produced from public lands***Total**

Fiscal year	Production (barrels)	Royalty oil (barrels)	Royalty value			Total
			Oil	Gas	Gasoline	
1921-1925.....	118,333,964.01	21,884,217.52	\$32,938,494.47	\$398,543.30	\$251,197.70	\$33,588,235.47
1926.....	29,712,876.16	4,431,563.63	7,951,665.52	93,508.29	154,265.43	8,199,439.34
1927.....	25,648,101.43	3,562,124.54	5,741,485.97	91,796.54	173,172.59	6,006,455.10
1928.....	23,370,549.38	3,142,027.63	3,519,810.55	108,570.86	107,070.00	3,735,451.41
	197,065,480.98	33,019,933.32	50,151,456.51	692,418.99	685,705.72	51,529,581.22

1928, by States

California.....	6,334,748.72	818,731.50	\$649,039.95	\$3,000.61	\$22,006.78	\$674,647.34
Colorado.....	921,640.81	74,270.82	48,229.25	3,292.25	109.45	51,631.45
Louisiana.....	9,509.01	973.00	1,749.58	1,868.24	211.39	3,829.21
Montana.....	768,285.87	44,634.02	75,923.93	2,009.32		77,933.25
New Mexico.....	72,383.96	12,618.56	12,054.11	1,187.00	7.74	13,248.86
Oklahoma.....	602,165.40	95,079.98	144,168.50		3,805.75	147,974.25
Utah.....	2,264.83	315.64	430.64	4,353.36		4,784.00
Wyoming.....	14,659,580.78	2,095,404.11	2,588,214.11	92,860.08	80,328.89	2,761,403.08

State details for previous years are given in the Forty-eighth Annual Report. In addition to the accrued royalties shown above, bonuses on sale of oil leases amounted to \$672,000 in California and \$300 in Wyoming in 1928.

Coal produced from leases, licenses, and permits on public lands, in tons, by fiscal years

State	1921-1925	1926	1927	1928	Total
Alaska.....	455,497.43	98,144.74	93,416.14	106,382.66	753,440.97
Alabama.....		10,056.00	22,854.00	43,523.00	76,433.00
California.....			3.00	3.00	6.00
Colorado.....	827,871.38	353,433.61	449,552.09	439,650.40	2,069,507.48
Montana.....	252,973.88	198,602.18	278,896.48	278,896.33	1,009,368.87
Nevada.....				91.15	91.15
New Mexico.....	74,427.26	37,461.86	85,905.31	74,462.82	272,257.25
North Dakota.....	463,698.38	163,533.79	215,540.12	404,456.71	1,247,228.00
Oregon.....	688.97	628.88	423.58	1,290.03	3,031.46
South Dakota.....	1,842.63	1,074.00	531.11	422.66	3,870.40
Utah.....	487,308.62	172,433.36	282,564.80	432,707.96	1,375,014.74
Washington.....	164,280.43	16,910.29	30,974.32	33,728.00	245,893.04
Wyoming.....	2,480,099.03	962,490.51	1,053,037.36	1,184,657.65	5,680,284.55
	5,207,679.71	3,014,769.19	2,512,696.31	3,000,248.38	12,735,393.59

Sodium salts disposed of from potassium leases (California), in tons, by fiscal years

1921-1925.....	3,145.30	1928.....	15,377.90
1926.....	430.09		
1927.....	5,911.35		24,804.73

Phosphate disposed of from phosphate leases (Idaho), in tons, by fiscal years

1921-1925.....	6,132.44	1928.....	23,459.95
1926.....	343.20		
1927.....	23,854.61		53,790.20

Sodium disposed of from sodium leases (Nevada), in tons, by fiscal years

1921-1925.....	248.25	1928.....	750.00
1926.....	233.53		
1927.....	302.53		1,534.33

ROYALTY, RENTALS, AND BONUSES

The following table summarizes the accrued income from mineral licenses, and prospecting permits, except oil and gas, involving public lands, under the Alaskan coal land leasing act of October 20, 1917, the general mineral-land leasing act of February 25, 1920, and the potassium act of February 7,

1923, royalties, rentals, and bonuses accrued from operations on public lands, by fiscal years and States

	Coal		Phos- phate	Potash	Bonuses	Total
	Leases	Permits				
1914-1919						
Alaska	\$2, 205. 00			\$835. 20		\$2, 205. 00
Idaho				230. 00		230. 00
Montana	2, 205. 00			1, 065. 20		3, 270. 20
1920						
Alaska	2, 970. 00			1, 670. 40		2, 970. 00
Idaho				460. 00		1, 670. 40
Montana	2, 970. 00			2, 130. 40		5, 100. 40
1921						
Alaska	4, 588. 71			2, 216. 34		4, 588. 71
Idaho	60. 00					2, 216. 34
Montana			\$185. 63			60. 00
Wyoming	43. 70	\$63. 88				185. 63
Idaho	800. 50				\$175. 00	63. 88
Montana	22, 835. 18			460. 00	5, 200. 00	218. 70
Wyoming						820. 50
1922						
Alaska	28, 328. 09	63. 88	185. 63	2, 676. 34	5, 395. 00	28, 495. 18
Idaho						36, 648. 94
Montana	5, 504. 46					5, 504. 46
Wyoming	4, 429. 81	1, 613. 21	226. 53	2, 231. 88		2, 231. 88
Idaho	259. 00	476. 25			2, 505. 00	6, 043. 02
Montana	1, 566. 47	157. 19			495. 00	226. 53
Wyoming	1, 743. 20					2, 505. 00
Idaho	5, 455. 97	49. 22			50, 174. 00	3, 240. 25
Montana	30. 00	6, 393. 26				2, 218. 66
Wyoming	32, 112. 34	327. 05		460. 00	10. 00	1, 743. 20
1923						
Alaska	51, 101. 25	9, 016. 18	226. 53	2, 691. 88	53, 184. 00	55, 679. 19
Idaho						6, 423. 26
Montana	4, 379. 57	3, 919. 19				32, 909. 39
Wyoming	18, 108. 30	6, 931. 44	180. 00		935. 00	51, 101. 25
Idaho	1, 034. 69	1, 092. 82				2, 691. 88
Montana	2, 190. 41	1, 577. 20				2, 231. 88
Wyoming	6, 705. 17	335. 00				2, 231. 88
Idaho		125. 93				935. 00
Montana	21, 641. 46	55. 11			238. 00	1, 034. 69
Wyoming	5, 285. 98	2, 006. 45				2, 190. 41
Idaho	40, 369. 80	2, 083. 50		460. 00	6. 00	6, 705. 17
1924						
Alaska	99, 715. 38	18, 126. 64	180. 00	2, 691. 88	1, 179. 00	21, 641. 46
Idaho						5, 285. 98
Montana						40, 369. 80
Wyoming						99, 715. 38

Royalty, rentals, and bonuses accrued from operations on public lands—Contd.

	Coal		Sodium	Phos- phate	Potash	Bonuses	Total
	Leases	Permits					
1924							
Alabama.....	\$460.00					\$85,000.00	\$85,460.00
Alaska.....	5,938.74						5,938.74
California.....					\$5,208.76		5,208.76
Colorado.....	22,783.92	\$3,881.86				25.00	26,690.78
Idaho.....				\$180.00			180.00
Montana.....	1,648.02	1,216.29					2,864.31
New Mexico.....	3,650.99	692.83					4,343.82
North Dakota.....	9,569.90	21.56				400.00	9,991.46
Oregon.....		14.35					14.35
South Dakota.....		96.50					96.50
Utah.....	21,386.93	296.37				104.00	21,787.30
Washington.....	5,335.76	489.44					5,825.20
Wyoming.....	62,967.41	268.76			920.00		64,156.17
	133,741.67	6,977.95		180.00	6,123.76	85,529.00	232,552.38
1925							
Alabama.....	920.00						920.00
Alaska.....	5,636.75						5,636.75
California.....					7,079.19		7,079.19
Colorado.....	32,062.84	1,083.85				1,151.00	34,247.69
Idaho.....				339.22			339.22
Montana.....	23,517.41	632.25					24,149.66
Nevada.....			\$301.07				301.07
New Mexico.....	2,469.87	1,083.98					3,553.85
North Dakota.....	10,035.26						10,035.26
Oregon.....	872.45	65.35					937.80
South Dakota.....	58.94	118.23					177.17
Utah.....	38,328.27	311.20				1,050.00	39,699.47
Washington.....	2,666.02						2,666.02
Wyoming.....	90,862.19	930.98					91,833.17
	207,458.70	4,175.84	301.07	339.22	7,079.19	2,201.00	221,555.02
1926							
Alabama.....	1,005.60						1,005.60
Alaska.....	9,227.63						9,227.63
California.....					6,031.78		6,031.78
Colorado.....	60,342.95	87.66					60,430.61
Idaho.....				695.00			695.00
Montana.....	22,114.17	423.94					22,538.11
Nevada.....			2,160.00				2,160.00
New Mexico.....	3,288.34	7,304.66					10,593.00
North Dakota.....	12,248.50	67.00				5.00	12,320.50
Oregon.....	972.80						972.80
South Dakota.....	91.09	136.25					227.34
Utah.....	84,770.71	461.79				551.00	85,783.50
Washington.....	1,721.04						1,721.04
Wyoming.....	114,857.82	504.83					115,362.65
	310,640.65	8,986.13	2,160.00	695.00	6,031.78	556.00	329,369.56
1927							
Alabama.....	2,285.40						2,285.40
Alaska.....	11,327.50						11,327.50
California.....		.75			6,217.60		6,218.35
Colorado.....	53,563.28	6,548.69				5.00	60,116.97
Idaho.....				2,549.41			2,549.41
Montana.....	32,845.58	445.17					33,290.75
Nevada.....			1,440.00				1,440.00
New Mexico.....	9,873.85	1,450.00				125.00	11,448.85
North Dakota.....	15,251.37	27.77					15,279.14
Oregon.....	1,048.00						1,048.00
South Dakota.....	40.86						40.86
Utah.....	69,789.08					5.00	69,794.08
Washington.....	3,096.57						3,096.57
Wyoming.....	114,148.44	565.81					114,714.25
	313,269.93	9,038.19	1,440.00	2,549.41	6,217.60	135.00	332,650.13

y, rentals, and bonuses accrued from operations on public lands—Contd.

	Coal		Sodium	Phosphate	Potash	Bonuses	Total
	Leases	Permits					
1928							
	\$4,352.30						\$4,352.30
	19,470.99	\$24.20					19,495.19
		.76			\$9,402.40		9,403.16
	50,507.26	563.78				\$5.00	51,076.01
				\$2,529.85			2,529.85
	29,981.64	49.98					30,031.62
		22.79	\$1,440.00				1,462.79
xico	10,620.64	1,187.00				400.00	12,207.64
akota	29,143.40	600.48				590.00	30,323.88
	948.00						948.00
akota	43.32						43.32
	70,344.38	3,591.32					73,935.70
ton	3,492.84	2.38					3,495.22
g	147,548.81	453.72					148,002.53
	366,453.48	6,496.37	1,440.00	2,529.85	9,402.40	985.00	387,307.10

Summary

	\$2,205.00				\$1,065.20		\$3,270.20
	2,970.00				2,130.40		5,100.40
	28,328.09	\$63.88		\$185.63	2,676.24	\$5,396.00	36,648.94
	51,101.25	9,016.18		226.53	2,691.88	\$3,184.00	116,219.84
	99,715.38	18,126.64		180.00	2,691.88	1,179.00	121,892.90
	133,741.67	6,977.96		180.00	6,123.76	35,529.00	232,552.38
	207,458.70	4,175.84	\$301.07	339.22	7,079.19	2,201.00	221,555.02
	310,640.65	8,986.13	2,190.00	995.00	6,081.78	556.00	329,099.56
	313,269.93	9,038.19	1,440.00	2,549.41	6,217.60	135.00	332,650.13
	366,453.48	6,496.37	1,440.00	2,529.85	9,402.40	985.00	387,307.10
	1,515,884.15	62,881.18	5,341.07	6,865.64	46,110.43	149,164.00	1,786,266.47

ACTIVITIES ON NAVAL PETROLEUM RESERVES

behalf of the Bureau of Engineering, Department of the Navy, mineral-leasing division supervises oil and gas operations in petroleum reserves Nos. 1 and 2, in California, and No. 3, in Wyoming. On March 17, 1927, by Executive order, the administration of all naval petroleum reserves was vested in the Department of the Navy. In pursuance of this order a cooperative agreement was entered into under which supervision will be continued by the Geological Survey under the direction of the Secretary of the Navy as to matters of policy. Production from naval petroleum reserve No. 3, Wyoming, was definitely suspended in January, 1928. The total production to date of suspension is given below. Supervision for the future is confined to observation of gas pressure and consultation with the Navy Department. At the time of suspension there were 61 oil wells, 12 gas wells, 2 water wells, 8 abandoned wells, and 2 suspended wells (one above the second Wall sand and one deep test well). Five derricks had been erected but not drilling. Statistics of the production of petroleum, natural gas, and natural-gas gasoline from naval petroleum reserves are summarized as follows:

Petroleum produced from naval reserves, by fiscal years

Total

	Production (barrels)	Royalty (barrels)	Royalty value			
			Oil	Gas	Gasoline	Total
1921-1925.....	40,406,158.14	9,381,761.48	\$10,685,660.38	\$296,874.65	\$231,485.45	\$11,216,020.48
1926.....	12,755,382.16	2,779,100.13	3,310,658.54	114,247.75	152,490.36	3,577,396.65
1927.....	12,725,365.02	2,902,243.85	3,175,882.25	110,204.62	169,643.75	3,455,729.62
1928.....	9,839,859.19	2,303,557.85	1,933,890.81	133,819.74	164,674.84	2,232,375.39
	75,726,764.51	17,366,663.31	19,106,081.98	657,146.76	718,284.40	20,481,513.14

1928, by States

California:						
1921-1925.....	9,660,573.93	2,284,897.18	\$1,909,711.11	\$125,866.88	\$162,834.06	\$2,198,412.05
Wyoming:						
1923-1927.....	3,400,942.37	465,668.33	763,114.40	44,765.64	7,104.55	815,064.99
1928.....	149,285.26	18,660.67	24,169.70	7,952.86	1,840.76	33,963.32

State details for previous years are given in the Forty-eighth Annual Report.

ACTIVITIES ON INDIAN LANDS

On behalf of the Office of Indian Affairs the functions of the division include inspectional, regulatory, and advisory service in connection with the leasing and development of mineral deposits on tribal and restricted allotted Indian lands.

At the end of the year there were outstanding 55 departmental lead and zinc leases on restricted Quapaw Indian lands in Oklahoma, covering 7,284.43 acres. The production from these lands amounts to 15.5 per cent of the zinc and 3.9 per cent of the lead mined in the United States. The royalty for the fiscal year, amounting to \$894,820.30, was 9.49 per cent of the sale value of the ore mined. One lead and zinc lease was approved for restricted Cherokee lands, but no production was made during the year.

All operating mills on restricted Quapaw Indian lands are now equipped with flotation units, resulting in an increased recovery of approximately 11 per cent of the value of the rock. This equipment permits the mining of lower-grade ores and the re-treatment of former waste, with a corresponding increase of ore reserves and of royalties accruing to the Indians.

An aerial photographic mosaic of the lead and zinc district of the Quapaw Reservation, in northeastern Oklahoma, was completed in cooperation with the War Department and the Chamber of Commerce of Picher, Okla. The map depicts an area of about 150 square miles and has been of material aid in locating drill holes, estimating the volume of chat piles, selecting locations for remilling sites, and, to the Oklahoma Geological Survey, in preparing a map of the district.

The area of segregated Choctaw and Chickasaw coal and asphalt lands was reduced to 393,409.51 acres by sales and completion of payments. The area now under lease is 72,819.11 acres. Of 78 coal leases in effect 39 are being operated. Sixty mines are in operation. 35 are shut down, and 65 have been abandoned. The reported pro-

duction of coal for the year was 654,920.87 tons, with a royalty value of \$72,746.37.

On allotted restricted Cherokee, Choctaw, and Creek lands there were 22 producing and 41 nonproducing coal leases and 1 volcanic-ash lease in 1928. A production of 110,602.37 tons of coal and 19 tons of volcanic ash, with accrued royalty and rental value of \$13,788.16, was reported. The geologic work of remapping the outcrops of the several coal beds on segregated and allotted lands, begun in 1927, was continued, and approximately 580,000 acres had been examined up to September 1, 1928. More than 65,000 acres of coal previously unexplored was mapped in the course of this reexamination. A new map of the Stigler area resulting from the work done in 1927 was furnished to the Office of Indian Affairs during the year. About 200 miles of coal outcrop was photographed aerially by the War Department, and additional maps are now in preparation for publication by the Oklahoma Geological Survey. During the year an audit was made of all amounts due under coal leases on Indian lands in Oklahoma and submitted to the Office of Indian Affairs.

The supervision of oil and gas activities in Oklahoma, exclusive of the Osage Reservation, includes 10,515 leases, covering 929,753.17 acres, on which there are 5,731 producing oil and gas wells, summarized by jurisdiction or Indian agencies as follows:

Oil and gas leases in Oklahoma exclusive of the Osage Reservation

	Leases			Wells		Total royalty and rentals
	Nonproducing	Producing	Total	Producing	Being drilled	
Five Civilized Tribes:						
Cherokee.....		401				
Choctaw.....		67				
Creek.....		648				
Chickasaw.....		18				
Seminole.....		69				
	7,369	1,203	8,572	5,516	96	\$5,574,345.90
Kiowa Indian Agency:						
Kiowa.....	110	0	110	0	0	
Comanche.....	177	19	196	23	0	
Apache.....	4	6	10	16	0	
Wichita.....	34	0	34	0	0	
Caddo.....	41	0	41	0	0	
	366	25	391	39	0	98,528.52
Pawnee Indian Agency:						
Ponca.....	243	14	257	54	1	
Otoe.....	273	2	275	2	0	
Tonkawa.....	17	0	17	0	0	
Pawnee.....	205	21	226	55	2	
Kaw.....	57	4	61	34	0	
	795	41	836	145	3	244,491.27
Shawnee Indian Agency:						
Iowa.....	31	0	31	0	0	
Kickapoo.....	77	0	77	0	1	
Pottawatomie.....	71	3	74	7	4	
Sac and Fox.....	173	9	182	24	0	
Shawnee.....	301	0	301	0	0	
	553	12	565	31	5	176,107.64
Cheyenne and Arapaho Indian Agency:	151	0	151	0	0	32,911.84
Grand total.....	9,234	1,281	10,515	5,731	104	\$6,126,385.26

Outside Oklahoma supervision was exercised over oil and gas leases on tribal and restricted allotted Indian lands as follows:

Oil and gas leases on Indian lands outside Oklahoma

State and tribe	Being tested	Pro-ducing	Non-pro-ducing	Under super-vision	Total wells
Colorado:					
Ute tribal.....	5	3	4	7	29
Ceded Utes.....					50
Montana:					
Blackfeet, tribal.....	1	0	3	3	0
Blackfeet, allotted.....	0	0	10	10	1
Crow, tribal.....	4	1	4	5	15
Crow, allotted.....	9	2	29	31	5
New Mexico:					
Navajo, tribal.....	3	3	12	15	56
Navajo, allotted.....	0	0	45	45	
Utah:					
Navajo, executive order.....	1	0	1	1	5
Wyoming:					
Shoshone, tribal.....	1	13	48	61	82
Allotted.....	2	8	5	13	130
	26	30	161	191	366

In connection with mining operations in progress or contemplated on Indian lands, special investigations were made for the Office of Indian Affairs in 1928 as follows:

Arizona: Colorado River Indian Reservation, 1 application for gold and lead lease; Fort Apache Indian Reservation, 1 coal operation, 2 asbestos leases; San Carlos Indian Reservation, 2 asbestos leases, 1 application for building-stone lease; Pima Indian Reservation, 1 application for feldspar and mica lease.

Colorado: Southern Ute Reservation, 1 tribal coal lease.

Montana: Rocky Boy Indian Reservation, 1 application for silver and lead lease.

OTHER COOPERATIVE WORK

The division cooperated with the Bureau of Mines and Bureau of Standards in connection with tests of mine stoppings to withstand explosions of gas and coal dust; with the Bureau of Mines in its rock-dusting, ventilation, and experimental mine programs and in its oil and gas technologic instigations; with the Industrial Commission of Utah in inspecting mines for the safety of the employees; with the Treasury Department in a report on the possibility of damage resulting from mining operations under the post-office building at Butte, Mont.; with the Bureau of Reclamation in reporting on the plant and coal mine at Williston, N. Dak.; with the National Research Council on the conservation of the scientific results of drilling and the improvement of drilling methods and equipment; and with the committee appointed by the Governor of Oklahoma to revise the mining law of Oklahoma.

Cooperation with State conservation agencies and individual oil and gas operators has resulted in more effective use of cement in plugging and abandoning wells under State supervision, and in the reduction of the amount of gas used in oil production and of that wasted at casing-head gasoline plants.

In cooperation with State officials, oil and gas operators, and Indian agencies in Oklahoma a daily waste of natural gas, conserva-

tively estimated at 100,000,000 cubic feet, has been stopped, and the gas conserved for domestic and industrial use.

Cooperation with oil operators in the Iles field, Colorado, has resulted in the development of a casing program that has reduced drilling costs and assured protection of oil and gas deposits in five productive zones. Peg models of the Elk Basin and Hudson oil fields, Wyoming, have been constructed in cooperation with the operators in those fields.

COST OF SUPERVISION AND STATE BENEFITS

Leases and permits involving publicly owned mineral deposits have been issued in 21 States and Alaska. These States receive direct, without expense to themselves, 37.5 per cent of all royalties, rentals, and bonuses derived from leases and permits within their respective boundaries and participate likewise in the benefits resulting from the expenditure of an additional 52.5 per cent of such funds by the Bureau of Reclamation. Only 10 per cent of the income is paid into the Federal Treasury to be available for paying the costs of necessary Federal administration.

Preliminary estimates indicate that the cost of the supervisory work of the mineral-leasing division averaged less than 2.5 per cent of the aggregate income from the leases on public and Indian lands in the fiscal year 1928. This indicates a slight increase in supervisory cost compared with 1927, but the increase is apparent rather than real and is due entirely to decrease in 1928 in the sale value of oil, gas, lead, and zinc.

WORK ON PUBLICATIONS

TEXTS

During the year 23,193 pages of manuscript were edited and prepared for printing by the section of texts, and 2,686 galley proofs and 11,260 page proofs were read and corrected. Indexes were prepared for 24 publications, covering 5,670 pages. Copy and proof or stencils for 1,114 pages of multigraph and mimeograph matter were read. At the end of the fiscal year five persons were employed in this section.

ILLUSTRATIONS

The number of drawings prepared by the section of illustrations was 2,605, including 133 maps, 307 sections and diagrams, 408 photographs, and 1,687 paleontologic drawings; 183 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany 60 reports numbered 1,416, to be reproduced by chromolithography, photolithography, halftone, and zinc etching. The number of proofs received and examined was 1,423. At the end of the year material for illustrating 23 reports is in hand. The section consists of 11 employees.

GEOLOGIC EDITING AND DRAFTING OF MAPS AND ILLUSTRATIONS

The geologic map of New Mexico reached the stage of color proof and was approved for printing. Folio 221 (Bessemer-Vandiver, Ala.) was published during the year. The maps and sections of

folios 223 (Coatesville-West Chester, Pa.) and 225 (Fairfield-Gettysburg, Pa.) were well advanced toward color proof. The maps of folio 222 (Gaffney-Kings Mountain, S. C.-N. C.) were approved for transfer to stone. The maps of folios 224 (Somerset-Windber, Pa.) and 226 (Montevallo-Columbiana, Ala.) were partly engraved. The maps of the Boston (Mass.) folio were prepared for engraving. The Hollidaysburg-Huntingdon (Pa.) folio was partly prepared for engraving, and the Cleveland (Ohio) folio, covering the Berea, Cleveland, and Euclid quadrangles, was received for publication. Maps and illustrations for 47 reports other than folios were edited for geology during the year, and geologic maps and illustrations for 28 reports were drawn for geologists in the geologic branch. Considerable progress was made on the compilation of the geologic map of the United States. The geologic map of Virginia was compiled in cooperation with the Virginia Geological Survey, and its publication was well advanced toward color proof. The geologic map of Pennsylvania, which is being compiled in cooperation with the Pennsylvania Geological Survey, was well advanced and nearly ready for engraving.

INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

During the year 86 new topographic maps were edited and transmitted for engraving; 208 published topographic maps, 8 State maps, and 18 State index circulars were edited for reprint; 25 plan and profile river-survey sheets were edited for two-color photolithography; 4 miscellaneous new maps were edited for photolithography; and 357 maps were edited as illustrations for Geological Survey reports—a total of 706 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 577 and proofs of maps reproduced by photolithography in one to four colors numbering 178 were read. At the end of the year 121 new topographic maps were in progress of engraving and printing and 115 new topographic maps and projects were in preparation for submission for reproduction.

DISTRIBUTION

A total of 368 publications, comprising 47 new books and pamphlets, 5 reprinted books, 1 new geologic folio, 150 new or revised topographic and other maps, and 165 reprinted topographic and other maps were received by the division of distribution during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 144,212 books and pamphlets, 4,428 geologic folios, and 750,415 topographic and other maps—a grand total of 899,055.

The division distributed 148,825 books and pamphlets, 6,103 geologic folios, and 851,960 maps—a total of 1,006,888, of which 5,111 folios and 699,365 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$48,762.35, including \$46,781.29 for topographic and geologic maps and \$1,981.06 for geologic folios. In addition to this, \$1,796.38 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$50,558.73.

The division received and answered 88,200 letters.

ENGRAVING AND PRINTING**TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS**

During the fiscal year 106 new topographic maps were engraved and printed, including 18 revised maps, and 44 new maps were photolithographed and printed, making a total of 150 new maps printed and delivered. Corrections were engraved on the plates of 175 maps. Reprint editions of 155 engraved topographic maps and 10 photolithographed State and other maps were printed and delivered. In addition, 36 new topographic maps had been engraved and were in press June 30, and the engraving of 15 other new topographic maps was nearly completed. Of new and reprinted maps, 315 different editions, amounting to 748,860 copies, were delivered. One new geologic folio was printed, its edition amounting to 4,428 copies. Extra geologic sheets of folios numbering 1,555 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, the office of the Secretary of the Interior, the Bureau of Mines, Bureau of Reclamation, Bureau of Education, General Land Office, National Park Service, Office of Indian Affairs, Alaska Railroad, Bureau of Public Roads, Bureau of Agricultural Economics, Bureau of Animal Industry, Bureau of Plant Industry, Forest Service, Bureau of Standards, Bureau of Lighthouses, Bureau of Foreign and Domestic Commerce, Department of Labor, Department of State, War Department, Post Office Department, Treasury Department, Department of Agriculture, Department of Commerce, Interstate Commerce Commission, Federal Power Commission, National Capital Park and Planning Commission, Commission of Fine Arts, International Boundary Commission, Federal Trade Commission, Civil Service Commission, Smithsonian Institution, National Research Council, Bureau of Internal Revenue, Veterans' Bureau, Federal Board for Vocational Education, Office of the Chief of Engineers, Bureau of Efficiency, Marine Corps, Regional Plan of New York and its Environs, Purdue University, and the States of Virginia, Idaho, Illinois, Oklahoma, Tennessee, North Carolina, and Arkansas. This work, done for other branches of the Government and State governments, included many reprints, and the charges for it amounted to about \$130,000, for which the appropriation for engraving and printing geologic and topographic maps was reimbursed by transfer of credit on the books of the Treasury Department.

Transfer impressions numbering 363 were made during the year, including 274 furnished to contracting lithographic printers on requisition of the Government Printing Office, 88 furnished to private firms, and 1 furnished to the American Zinc Institute. Other miscellaneous work was done for A. Hoen & Co., Williams & Heintz Co., Carnegie Institution, Encyclopædia Britannica, A. J. Nystrom Co., and the State of Illinois. The amount turned over to miscellaneous receipts from this work was \$225.91.

Of contract and miscellaneous work of all kinds, 2,453,534 copies were printed. Including topographic maps and geologic folios, a grand total of 3,208,377 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 7,531 negatives (638 wet, 126 paper, 2,132 dry, 3,945 field negatives, and lantern slides), 38,191 prints (4,549 maps and diagrams and 28 photographs for illustrations), 2,478 zinc plates, 284 zinc etchings, 77 celluloid prints, 64 lantern slides colored, 34 transparencies colored, 1 print colored, and 2,406 prints mounted.

*ADMINISTRATION**CORRESPONDENCE AND RECORDS*

The work of the section of correspondence and records was of same general character as during the preceding fiscal year. At the end of the year the appointees of the Secretary numbered 877, 42 more than at the end of the fiscal year 1927. The changes in personnel were 796, including 166 appointments, 124 separations, and 506 miscellaneous. During the calendar year 1927, 73 per cent of the possible annual leave and 13 per cent of the possible sick leave were granted. Leave without pay and furloughs amounting to 5,372 days were also granted.

LIBRARY

The year's accessions to the library comprised 14,316 books, pamphlets, and periodicals and 726 maps. The recorded loans were 5 books and 240 maps, in addition to those used by 9,105 readers who consulted the library in person. The catalogue was increased by the addition of 10,323 cards. Title entries to the number of 579 were furnished to the Library of Congress for printing, the proof reading of which involved 118 galleys.

Correspondence handled included 2,066 letters received and 1,100 letters sent. Letters and other writings in foreign languages to the number of 159 were translated for other divisions of the Geological Survey. There were 1,250 volumes collated and prepared for binding, and 1,078 newly bound volumes were labeled, plated, and shelf listed.

Numerous loans were made to libraries, both in Washington and other places, and a considerable volume of reference work was done in the usual course of the library's service to specialists and students both in the Geological Survey and others.

The manuscript of the bibliography of North American geology for 1925 and 1926 (Bulletin 802) was completed, and the proofs were read.

ACCOUNTS

Condensed statements covering the expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

ADMINISTRATION

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Appropriation	Funds available						Expenditures			Balance	
	Amount of appropriation	Repayments and transferred funds on account of work performed					Total	Disbursements	Outstanding liabilities		Total
		For cooperating agencies		For other Geological Survey units	Transferred funds						
		Made	To be made								
Salaries.....	\$128,500.00					\$128,500.00	\$128,303.72		\$17,019.90	\$128,303.72	\$196.28
Topographic surveys.....	510,200.00	\$199,287.12	\$31,231.99	\$8,599.18		\$4,600.00	743,098.29	722,094.87		790,114.77	4,703.53
Geologic surveys.....	328,200.00	17,558.09	6,828.64	80.40		9,745.88	363,392.71	348,637.23		345,183.15	7,292.56
Volcanologic surveys.....	20,000.00						20,000.00	18,151.26		6,513.92	965.22
Mineral resources of Alaska.....	60,000.00						60,000.00	58,367.09		19,034.78	186.00
Gaging streams.....	147,000.00	191.42	40,872.87	5,490.49		707.30	60,968.72	383,247.76		60,713.72	303.13
Classification of lands.....	200,000.00	139,331.15	2,905.27			50,281.69	383,976.20	376,747.76		5,923.31	5,181.66
Geologic and topographic maps of the United States.....	88,400.00	90,363.36	18,168.69	20,247.37		17,395.00	284,564.42	220,327.98		9,005.00	4,690.84
Preparation of illustrations.....	24,580.00						24,580.00	23,702.99		2.65	\$74.36
Mineral leasing.....	303,000.00	240.53				58,210.05	361,450.59	353,821.58		3,097.10	3,981.91
	1,807,880.00	439,864.94	97,092.19	34,407.44		140,939.63	2,520,176.20	2,437,854.45		54,020.27	\$88,201.48
										\$2,491,874.72	

* In addition to these appropriations, items of \$109,000 for printing and binding Geological Survey publications and \$11,000 for miscellaneous printing and binding were contained in the appropriation act, but the accounts for these items were not kept in the Geological Survey. There was also an allotment of \$15,763.95 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

* Of these totals, \$7,097.53 is in the hands of special disbursing agents and therefore has not been included in the classification of expenditures, as no vouchers covering disbursements have been received.

* Included in this amount is \$34,407.44 covering work performed by Geological Survey units for other Geological Survey units, necessarily reported in combining totals, but otherwise a duplication.

* A budget reserve of \$850 is included in this balance.

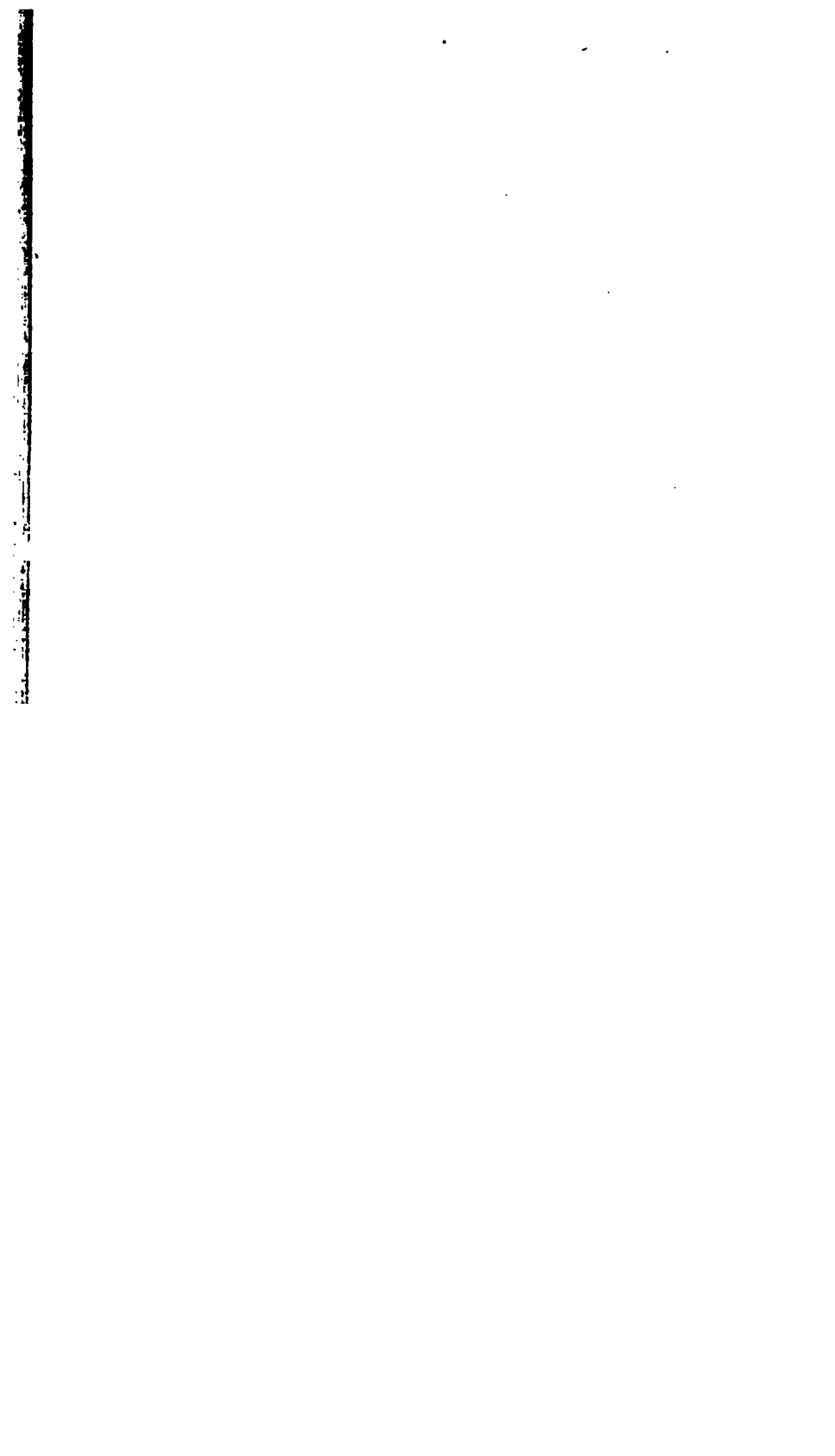
Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1928

Object of expenditure	Geological Survey salaries	Topographic surveys	Geologic surveys	Volcanologic surveys	Mineral resources of Alaska	Gaging streams	Classification of lands	Geologic and topographic maps of the United States	Preparation of maps and illustrations	Mineral leasing	Total
Personal services	\$120,303.72	\$527,766.99	\$300,661.21	\$15,732.83	\$38,937.41	\$278,288.76	\$153,453.64	\$177,401.65	\$23,279.65	\$265,272.34	\$1,908,910.20
Stationery and office supplies		8,057.37	609.61	174.64	1,144.50	1,200.23	184.77	21,946.11		151.78	33,502.01
Scientific and educational supplies		1,268.94	1,268.94	140.72	1,652.02	248.86	315.14		24.42	291.67	5,210.81
Sundry supplies		2,520.80	1,046.09	181.91	118.79	1,700.62	386.03	5,699.33	18.06	846.21	12,519.04
Subsistence and care of animals and storage and care of vehicles		986.50	223.13								1,209.63
Storage of passenger-carrying vehicles		41.04					78.75			38.00	157.79
Storage of freight-carrying vehicles		955.94	42.88				21.00				1,019.82
Telephone service		643.93	156.05	2.92	83.04	378.06	55.25	3.18	.29	417.29	1,730.98
Other communication service		216.92	149.96	27.80	1.20	825.21	74.80			2,590.10	3,885.09
Travel expenses		13.85				16.50	1.50			57.00	85.85
Attendance at meetings		87,087.89	22,532.66	1,420.80	5,064.97	37,331.45	18,656.80	87.20		25,955.45	198,146.22
Hire, maintenance, operation, and repair of horse-drawn and motor-propelled passenger-carrying vehicles		450.55	1,357.29		45.25	179.22				798.04	2,830.35
Transportation of things, and engraving											
Stenographic work, typewriting, and duplicating work, etc. (Job work)		2,958.91	2,981.30	536.06	10.00	8,380.73	6,457.88			20,094.33	41,399.21
Photographing and making photographs and prints		25,021.56	5,638.61	180.11	2,723.63	4,400.22	4,311.60	80.60	9.01	1,818.36	54,183.71
Heat, light, power, water, and electricity		12,135.58	396.56			597.06	591.09	42.86	133.19	54.16	13,960.50
Rents			8.20			6.00	.60			.50	15.30
Repairs and alterations		2,375.17	3,761.30	84.93	172.14	847.46	3,321.30		204.47	2,819.28	13,586.06
Special and miscellaneous current expenses		49.14	29.40	42.00	40.08						4,541.52
Purchase of passenger-carrying vehicles		209.51	118.60	79.50	27.25	1,739.47	264.88	597.67		4,430.04	8,990.89
Furniture, furnishings, and fixtures		19,756.40	711.12	13.80	134.73	1,294.15				7,211.28	3,973.75
Educational and scientific equipment		613.44	621.60	33.41	6,297.67	6,297.67	233.85	10,944.47		577.41	33,589.53
Livestock		2,782.96	585.22	53.99	47.83	922.75	1,557.48			8,253.23	16,727.71
Other equipment			5,221.48		654.77	18,837.29	2,392.79	2,264.83	35.99	2,781.58	5,541.81
Miscellaneous transfers and adjustments		27,278.39	6,145.26	239.76	375.00	14,813.90	3,422.55	5,232.55		1,515.87	33,759.97
					41.00					1,095.59	58,296.00
		4,371.36	1,005.07	80.60	3,975.01	3,189.70	1,384.70	5,630.13		9,056.98	28,683.55
		737,592.24	355,163.15	19,034.78	56,138.72	382,673.07	197,723.61	229,983.58	23,705.04	367,518.68	2,494,777.19

GEORGE OTIS SMITH,
Director.

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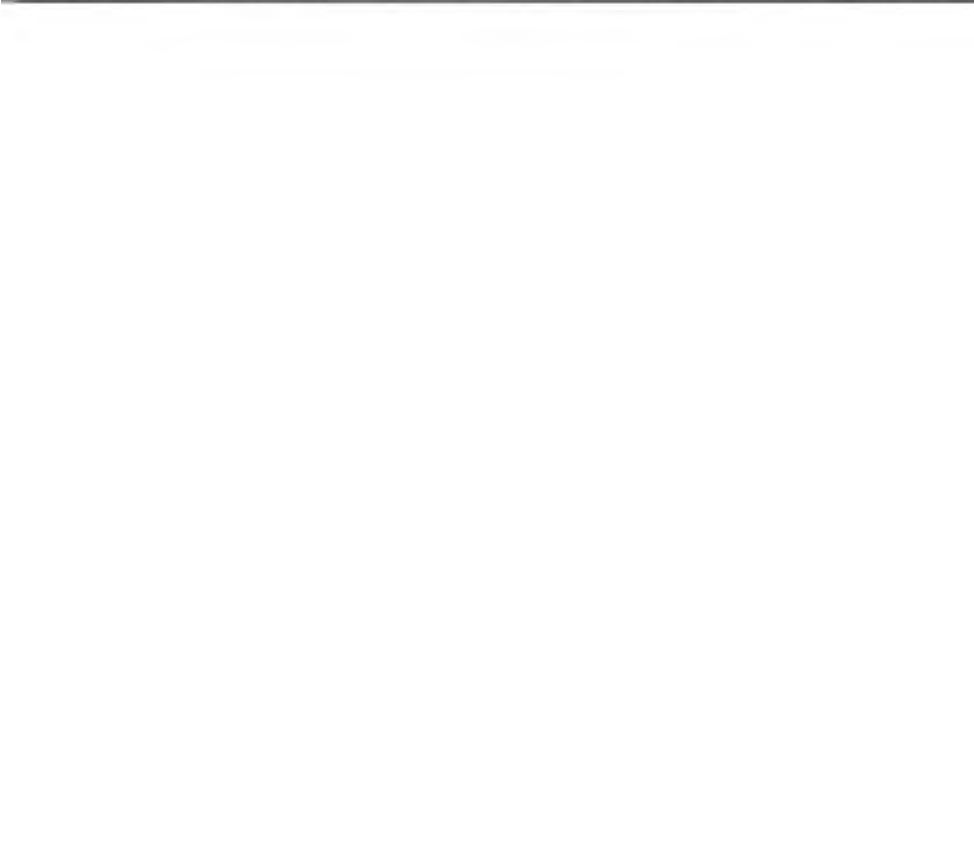
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UNITED STATES DEPARTMENT OF THE INTERIOR

*ANNUAL REPORT OF THE
DIRECTOR OF
THE GEOLOGICAL SURVEY
TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1929*



UNITED STATES DEPARTMENT OF THE INTERIOR

FIFTIETH ANNUAL REPORT

OF THE

*DIRECTOR OF
THE GEOLOGICAL SURVEY*

TO THE

SECRETARY OF THE INTERIOR

1929



*UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1929*





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Directors of the Geological Survey

CLARENCE KING, 1879-1881
JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907
GEORGE OTIS SMITH, 1907-

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U.S. Geol.
12-16-1929

ANNUAL REPORT OF THE DIRECTOR OF THE GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 15, 1929.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1929 included 14 items, amounting to \$2,135,609. In addition \$120,000 was appropriated for printing and binding for the Geological Survey, and an allotment of \$14,765 for miscellaneous supplies was made from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of this report. The balance on July 31 was \$28,165.

The total amount of funds made available for disbursement by the Geological Survey, together with State funds directly disbursed for work administered by the Federal officials, was \$3,875,332.

FIFTY YEARS OF SERVICE

The United States Geological Survey was created by act of Congress approved March 3, 1879. It was the successor of four Federal organizations that had been making topographic, geologic, and other scientific and economic surveys in the territory west of the one hundredth meridian, under the leadership of Clarence King, F. V. Hayden, G. M. Wheeler, and J. W. Powell. On March 21, 1879, President Hayes appointed Clarence King the first Director of the United States Geological Survey. In the half century that has passed since that time the Geological Survey has grown in stature, widened its field of endeavor, and increased its usefulness, but it has not grown old. Its outstanding characteristic, which has tinged all its work and been its chief asset, is the fact that it is primarily a field service—its men have traveled far and wide and know by intimate contact the country that the organization serves. Through these 50 years thousands of young men have come under that broadening influence. The far-reaching outlook of specialized public service that is possessed by many men in high position in this country is a by-product of the United States Geological Survey.

During this half century the Federal funds made available annually for the work of the Geological Survey have increased from \$100,000 to more than \$2,000,000. The total expenditures for the 50 years have been \$75,000,000, of which nearly \$10,000,000 has been contributed by States for cooperative work. Most of the work on

which these millions have been expended may be described by the simple term "fact finding." The Geological Survey has been continuously engaged in research—in bringing to light facts that have been of essential importance in the marvelous development of our country since 1879. When the Geological Survey made its first census of mineral production, the treasure house of the country had hardly been opened; since then the mineral industry has increased fifteenfold. The research work of the Geological Survey has not been confined to investigations whose immediate economic value is self-evident. Realizing that the pure science of to-day becomes the applied science of to-morrow, it has neglected no phase of the study of the earth. Its methods of work and the men it has trained have powerfully shaped the course of development of the science of geology.

The topographic maps that have been necessary to provide an accurate base upon which to represent the facts ascertained by the geologic work have now attained so high a degree of exactness that they are sought for themselves alone by all classes of the people—from engineer to vacation tourist. The investigations of water, our greatest mineral resource, have thrown light on the complex problems of public water supply, inland navigation, flood prevention, reclamation by both drainage and irrigation, and the development of power. The activities of the Geological Survey in respect to the vast mineral estate comprised in the public land, of which nearly 200,000,000 acres still remains unappropriated, have been based on the practical policy of planning for its future use without waste of the resources and for the intelligent distribution of that use as to time—between our day and our children's day.

Not the least of the accomplishments of the Geological Survey during its first half century has been its service as the mother of other organizations that are playing essential parts in the study of our country and the development of its resources. The work that is being done by the Bureau of American Ethnology, the Forest Service, the Bureau of Reclamation, the Bureau of Mines, and the Geophysical Laboratory of the Carnegie Institution had its beginnings in the Geological Survey.

The publications by which the results of the multiform investigations of the Geological Survey have been made available in permanent form now comprise more than 400,000 printed pages and occupy 120 feet of shelf room—twenty-four "5-foot shelves" of recorded facts and conclusions concerning the unequalled natural resources of the United States.

PUBLICATIONS OF THE YEAR

The following publications were issued during the fiscal year 1929:

ANNUAL REPORT

Forty-ninth Annual Report of the Director of the Geological Survey.

PROFESSIONAL PAPERS

144. The copper deposits of Michigan, by B. S. Butler and W. S. Burbank, in collaboration with T. M. Broderick, L. C. Graton, C. D. Hohl, Charles Palache, M. J. Scholz, Alfred Wandke, and R. C. Wells.

150. Shorter contributions to general geology, 1927.
 153. Studies of Basin Range structure, by G. K. Gilbert.
 154-B. The fauna of the middle Boone near Batesville, Ark., by G. H. Girty.
 154-C. Salinity of the water of Chesapeake Bay, by R. C. Wells, R. K. Bailey, and E. P. Henderson.
 154-D. Origin of the siliceous Mowry shale of the Black Hills region, by W. W. Rubey.
 154-E. Oil shale in a producing oil field in California, by H. W. Hoots.
 154-F. Water-laid volcanic rocks of early Upper Cretaceous age in southwestern Arkansas, southeastern Oklahoma, and northeastern Texas, by C. S. Ross, H. D. Miser, and L. W. Stephenson.
 154-G. Algae reefs and oolites of the Green River formation, by W. H. Bradley.
 154-H. A revision of the flora of the Latah formation, by E. W. Berry.
 154-I. *Erogyra olisiponensis* Sharpe and *Erogyra costata* Say in the Cretaceous of the Western Interior, by J. B. Reeside, jr.
 154-J. Additions to the flora of the Green River formation, by R. W. Brown.
 157. The Mother Lode system of California, by Adolph Knopf.
 158-A. The occurrence and origin of analcite and meerschaum beds in the Green River formation of Utah, Colorado, and Wyoming, by W. H. Bradley.

BULLETINS

775. Geology and lignite resources of the Marmarth field, southwestern North Dakota, by C. J. Hares.
 788. Topographic instructions of the United States Geological Survey.
 794. "Red Beds" and associated formations in New Mexico, with an outline of the geology of the State, by N. H. Darton.
 797-B. The Skwentna region, Alaska, by S. R. Capps.
 797-C. Preliminary report on the Sheenjek River district, Alaska, by J. B. Mertle, jr.
 797-D. Surveys in northwestern Alaska in 1926, by P. S. Smith.
 797-E. Aerial photographic surveys in southeastern Alaska, by R. H. Sargent and F. H. Moffit.
 797-F. Geology and mineral resources of the Aniakchak district, Alaska, by R. S. Knappen.
 798. Geology of the Muddy Mountains, Nev., with a section through the Virgin Range to the Grand Wash Cliffs, Ariz., by C. R. Longwell.
 801. Geology and water resources of the Edgeley and La Moure quadrangles, N. Dak., by H. A. Hard.
 802. Bibliography of North American geology, 1925 and 1926, by J. M. Nickles.
 803. Geography, geology, and mineral resources of the Portneuf quadrangle, Idaho, by G. R. Mansfield.
 804. Geology and coal and oil resources of the Hanna and Carbon Basins, Carbon County, Wyo., by C. E. Dobbin, C. F. Bowen, and H. W. Hoots.
 805. Contributions to economic geology (short papers and preliminary reports), 1928, Part I, Metals and nonmetals except fuels.
 805-A. Platinum and black sand in Washington, by J. T. Pardee.
 805-B. Deposits of vermiculite and other minerals in the Rainy Creek district, near Libby, Mont., by J. T. Pardee and E. S. Larsen.
 806-A. The Pumpkin Buttes coal field, Wyo., by C. H. Wegeman, R. W. Howell, and C. E. Dobbin.
 806-B. The northward extension of the Sheridan coal field, Big Horn and Rosebud Counties, Mont., by A. A. Baker.
 806-C. Geology and oil and gas prospects of part of the San Rafael Swell, Utah, by James Gilluly.
 806-D. Geology of the Rock Creek oil field and adjacent areas, Carbon and Albany Counties, Wyo., by C. E. Dobbin, H. W. Hoots, C. H. Dane, and E. T. Hancock.
 806-E. Thrust faulting and oil possibilities in the plains adjacent to the Highwood Mountains, Mont., by Frank Reeves.
 807. Geology of Hyder and vicinity, southeastern Alaska, with a reconnaissance of Chickamin River, by A. F. Buddington.
 810-A. Mineral industry of Alaska in 1927 and administrative report, by P. S. Smith [with selected list of Geological Survey publications on Alaska].

WATER-SUPPLY PAPERS

540. Ground water in the New Haven area, Conn., by J. S. Brown.
 571. Surface water supply of the United States, 1923, Part XI, Pacific slope slope basins in California.
 581. Surface water supply of the United States, 1924, Part I, North Atlantic slope drainage basins.
 582. Surface water supply of the United States, 1924, Part II, South Atlantic slope and eastern Gulf of Mexico basins.
 586. Surface water supply of the United States, 1924, Part VI, Missouri River Basin.
 588. Surface water supply of the United States, 1924, Part VIII, Western Gulf of Mexico basins.
 589. Surface water supply of the United States, 1924, Part IX, Colorado River Basin.
 590. Surface water supply of the United States, 1924, Part X, The Great Basin.
 591. Surface water supply of the United States, 1924, Part XI, Pacific slope basins in California.
 593. Surface water supply of the United States, 1924, Part XII, North Pacific slope drainage basins: B, Snake River Basin.
 594. Surface water supply of the United States, Part XII, North Pacific slope drainage basins: C, Lower Columbia River Basin and Pacific slope drainage basins in Oregon.
 595. Surface water supply of Hawaii, July 1, 1923, to June 30, 1924.
 596. Contributions to the hydrology of the United States, 1927.
 597-A. Geology of reservoir and dam sites, with a report on the Owyhee Irrigation project, Oreg., by Kirk Bryan.
 597-B. A study of ground water in the Pomperaug Basin, Conn., with special reference to intake and discharge, by O. E. Meinzer and N. D. Stearns.
 597-C. Problems of the soft-water supply of the Dakota sandstone, with special reference to the conditions at Canton, S. Dak., by O. E. Meinzer.
 597-D. Geology and water resources of the upper McKenzie Valley, Oreg., by H. T. Stearns.
 597-E. Surface water supply of the Sacramento River Basin, Calif., 1895-1927, by H. D. McGlashan.
 611. Surface water supply of the United States, 1925, Part XI, Pacific slope basins in California.
 612. Surface water supply of the United States, 1925, Part XII, North Pacific slope drainage basins: A, Pacific basins in Washington and upper Columbia River Basin.
 636-A. Quality of water of the Colorado River in 1926-1928, by C. S. Howard.

GEOLOGIC ATLAS

Geologic map of New Mexico.

TOPOGRAPHIC AND OTHER MAPS

[The figures in parentheses indicate limiting parallels and meridians of the areas covered]

Alabama:

Samantha (33° 15'-33° 30'; 87° 30'-87° 45').

Arizona:

Buck Mountains (34° 30'-34° 45'; 114°-114° 15').

Fortuna (32° 30'-32° 45'; 114° 15'-114° 30').

Mohawk (32° 30'-32° 45'; 113° 45'-114°).

Norton (32° 45'-33°; 113° 45'-114°).

Wellton (32° 30'-32° 45'; 114°-114° 15').

Arizona-California:

Laguna (32° 45'-33°; 114° 15'-114° 30').

Arkansas:

State, scale 1:500,000.

California (see also Arizona-California):

Corcoran (36°-36° 7' 30''; 119° 30'-119° 37' 30'').

Eden Valley (39° 30'-39° 45'; 123°-123° 15').

Glendale (34° 6'-34° 12'; 118° 12'-118° 18').

Guernsey (36° 7' 30''-36° 15'; 119° 37' 30''-119° 45').

- Lassen Volcanic National Park ($40^{\circ} 25' - 40^{\circ} 35'$; $121^{\circ} 15' - 121^{\circ} 35'$).
 Lindsay ($36^{\circ} 7' 30'' - 36^{\circ} 15'$; $119^{\circ} - 119^{\circ} 7' 30''$).
 San Pedro Hills ($33^{\circ} 42' - 33^{\circ} 48'$; $118^{\circ} 18' - 118^{\circ} 26'$).
 Tipton ($36^{\circ} - 36^{\circ} 7' 30''$; $119^{\circ} 15' - 119^{\circ} 22' 30''$).
 Waukena ($36^{\circ} 7' 30'' - 36^{\circ} 15'$; $119^{\circ} 30' - 119^{\circ} 37' 30''$).
 Westhaven ($36^{\circ} 7' 30'' - 36^{\circ} 15'$; $119^{\circ} 52' 30'' - 120^{\circ}$).
 Woodville ($36^{\circ} - 36^{\circ} 7' 30''$; $119^{\circ} 7' 30'' - 119^{\circ} 15'$).
 Yosemite National Park ($37^{\circ} 30' - 38^{\circ} 15' 30''$; $119^{\circ} - 120^{\circ}$).
- Colorado:**
 Highmore ($39^{\circ} 30' - 39^{\circ} 45'$; $108^{\circ} 15' - 108^{\circ} 30'$).
- District of Columbia-Maryland-Virginia:**
 Washington and vicinity ($38^{\circ} 45' - 39^{\circ} 5'$; $76^{\circ} 52' 30'' - 77^{\circ} 15'$).
- Georgia.** (See South Carolina-Georgia.)
- Hawaii:**
 Haleakala ($20^{\circ} 35' - 20^{\circ} 45'$; $156^{\circ} - 156^{\circ} 15'$).
 Honaunau ($19^{\circ} 15' - 19^{\circ} 30'$; $155^{\circ} 45' - 155^{\circ} 57' 30''$).
 Hoopuloa ($19^{\circ} - 19^{\circ} 15'$; $155^{\circ} 45' - 155^{\circ} 57' 30''$).
 Kahoolawe ($20^{\circ} 30' - 20^{\circ} 45'$; $156^{\circ} 30' - 156^{\circ} 42' 30''$).
 Keahole ($19^{\circ} 37' 30'' - 19^{\circ} 52' 30''$; $156^{\circ} - 156^{\circ} 12' 30''$).
 Koolau ($20^{\circ} 45' - 20^{\circ} 57' 30''$; $156^{\circ} - 156^{\circ} 15'$).
 Mauna Loa ($19^{\circ} 15' - 19^{\circ} 30'$; $155^{\circ} 30' - 155^{\circ} 45'$).
 Nihaui ($21^{\circ} 40' - 22^{\circ} 2'$; $160^{\circ} 2' - 160^{\circ} 15'$).
- Idaho:**
 Craters of the Moon National Monument ($43^{\circ} 16' - 43^{\circ} 30'$; $113^{\circ} 25' - 113^{\circ} 36'$).
 State, scale 1:500,000.
- Illinois** (see also Kentucky-Illinois):
 Brighton ($39^{\circ} - 39^{\circ} 15'$; $90^{\circ} - 90^{\circ} 15'$).
 Chicago Loop ($41^{\circ} 52' 30'' - 42^{\circ}$; $87^{\circ} 37' 30'' - 87^{\circ} 45'$).
 Evanston ($42^{\circ} - 42^{\circ} 7' 30''$; $87^{\circ} 37' 30'' - 87^{\circ} 45'$).
 Tinley Park ($41^{\circ} 30' - 41^{\circ} 37' 30''$; $87^{\circ} 45' - 87^{\circ} 52' 30''$).
- Illinois-Indiana:**
 Jackson Park ($41^{\circ} 45' - 41^{\circ} 52' 30''$; $87^{\circ} 30' - 87^{\circ} 37' 30''$).
- Indiana.** (See Illinois-Indiana.)
- Iowa:**
 Albia ($41^{\circ} - 41^{\circ} 15'$; $92^{\circ} 45' - 93^{\circ}$).
- Kansas-Nebraska:**
 Southwestern Nebraska and western Kansas ($37^{\circ} - 41^{\circ}$; $100^{\circ} - 109^{\circ}$; land classification).
- Kentucky.** (See Tennessee-Kentucky, Virginia-Kentucky, West Virginia-Kentucky, West Virginia-Virginia-Kentucky.)
- Kentucky-Illinois:**
 Smithland ($37^{\circ} - 37^{\circ} 15'$; $88^{\circ} 15' - 88^{\circ} 30'$).
- Maine:**
 Dead River ($45^{\circ} - 45^{\circ} 15'$; $70^{\circ} - 70^{\circ} 15'$).
 Dixfield ($44^{\circ} 30' - 44^{\circ} 45'$; $70^{\circ} 15' - 70^{\circ} 30'$).
- Maryland.** (See District of Columbia-Maryland-Virginia.)
- Michigan:**
 Lainsburg ($42^{\circ} 45' - 43^{\circ}$; $84^{\circ} 15' - 84^{\circ} 30'$).
- Missouri:**
 Cardareva ($37^{\circ} - 37^{\circ} 15'$; $91^{\circ} - 91^{\circ} 15'$).
 Des Arc ($37^{\circ} 15' - 37^{\circ} 30'$; $90^{\circ} 30' - 90^{\circ} 45'$).
- Montana:**
 Flathead Lake project ($48^{\circ} 3' - 48^{\circ} 13'$; $114^{\circ} 6' - 114^{\circ} 18'$).
- Nebraska** (see also Kansas-Nebraska):
 Northwestern Nebraska ($41^{\circ} - 43^{\circ}$; $100^{\circ} 10' - 104^{\circ} 3'$; land classification).
- New Hampshire:**
 Hillsboro ($43^{\circ} - 43^{\circ} 15'$; $71^{\circ} 45' - 72^{\circ}$).
 Mount Kearsarge ($43^{\circ} 15' - 43^{\circ} 30'$; $71^{\circ} 45' - 72^{\circ}$).
- New Hampshire-Vermont:**
 Averill ($44^{\circ} 45'$ to Canadian boundary; $71^{\circ} 30' - 71^{\circ} 45'$).
 Claremont ($43^{\circ} 15' - 43^{\circ} 30'$; $72^{\circ} 15' - 72^{\circ} 30'$).
- New York** (see also Pennsylvania-New York):
 Coxsackie ($42^{\circ} 15' - 42^{\circ} 30'$; $73^{\circ} 45' - 74^{\circ}$).
- North Carolina.** (See Virginia-North Carolina.)
- North Dakota:**
 Minot ($48^{\circ} - 48^{\circ} 15'$; $101^{\circ} 15' - 101^{\circ} 30'$).

Ohio. (See West Virginia-Ohio.)

Pennsylvania:

Gettysburg (39° 45'-40°; 77°-77° 15'; areal geology).

Gettysburg (economic geology).

Pennsylvania-New York:

Youngsville (41° 45'-42°; 79° 15'-79° 30').

South Carolina-Georgia:

Warrenville (33° 30'-33° 45'; 81° 45'-82°).

Tennessee:

Decherd (35°-35° 15'; 86°-86° 15').

Gordonsville (36°-36° 15'; 85° 45'-86°).

Tennessee-Kentucky:

Tompkinsville (36° 30'-36° 45'; 85° 30'-85° 45').

Texas:

Tankersly (31° 15'-31° 30'; 100° 30'-100° 45').

Waldrip (31° 15'-31° 30'; 99° 15'-99° 30').

Wall (31° 15'-31° 30'; 100° 15'-100° 30').

United States:

Physical divisions.

Utah:

Fort Douglas (40° 30'-41°; 111° 30'-112°).

Gold Hill (40°-40° 15'; 113° 45'-114°).

Vermont. (See New Hampshire-Vermont.)

Virginia (see also District of Columbia-Maryland-Virginia, West Virginia-Kentucky, West Virginia-Virginia-Kentucky):

Covesville (37° 45'-38°; 78° 30'-78° 45').

Virginia-Kentucky:

Big Stone Gap (36° 45'-37°; 82° 45'-83°).

Virginia-North Carolina:

Critz (36° 30'-36° 45'; 80°-80° 15').

West Virginia:

Ripley (38° 45'-39°; 81° 30'-81° 45').

Spencer (38° 45'-39°; 81° 15'-81° 30').

West Virginia-Kentucky:

Naugatuck (37° 45'-38°; 82° 15'-82° 30').

West Virginia-Ohio:

Point Pleasant (38° 45'-39°; 82°-82° 15').

Ravenswood (38° 45'-39°; 81° 45'-82°).

West Virginia-Virginia-Kentucky:

Matewan (37° 30'-37° 45'; 81° 45'-82°).

Wyoming:

Southeastern Wyoming (41°-43°; 104° 3'-107°; land classification).

THE YEAR'S OPERATIONS

The director continued his service as chairman of the advisory committee of the Federal Oil Conservation Board and as chairman of the Naval Oil Reserve Commission. During March to June, as the representative of the Federal Oil Conservation Board, he attended several oil conferences and as the personal representative of the Secretary of the Interior promoted oil conservation in California. This service involved 25,000 miles of travel.

For the purpose of bringing before the public the results of the work of his associates and in connection with his administration of the general work of the Geological Survey, as in other years, he made several addresses and informal talks and contributed articles to the press. These are listed below:

ADDRESSES

Empire builders, Columbia section, American Institute of Mining and Metallurgical Engineers, Spokane, Wash., July 20.

Washington development, Mining Association, Seattle, Wash., July 23.

Brakes for the mineral industry, American Bar Association, Seattle, Wash., July 24.

Our share in the Nation's business, joint meeting of the American Institute of Mining and Metallurgical Engineers and the American Mining Congress, Los Angeles, Calif., September 12.

Open mind and open forum, Petroleum division, American Institute of Mining and Metallurgical Engineers, Tulsa, Okla., October 18.

Address, Tri-State Zinc and Lead Association, Picher, Okla., October 22.

Address, Mid-Continent Oil and Gas Association, Tulsa, Okla., October 24.

Geophysical exploration, radio hearing, Interior Department, Washington, November 15.

Government work in aid of mining, American Institute of Mining and Metallurgical Engineers, New York City, December 20.

Engineering standards for society, address as retiring president, American Institute of Mining and Metallurgical Engineers, New York City, February 20.

Address, American Petroleum Institute, Houston, Tex., March 15.

Address, conference on oil conservation, Colorado Springs, Colo., June 10.

ARTICLES

Natural resources of the United States, 1927, American Journal of Sociology, July.

Conservation of oil, United States Daily, August 13.

National conservation, New York Herald-Tribune, November 18.

Geological Survey's oil studies of great importance to industry, Oil and Gas Journal, January 3.

Radio as a stop-watch for the geophysicist, New York Herald-Tribune, January 27.

Our field fact-finding, National Republic, April.

What the new oil policy means, Nation's Business, May.

Natural resources, 1928, American Journal of Sociology, May.

Secretary Wilbur has full authority for enforcing order, California Oil World, May 8.

California gas law is beneficial, California Oil World, May 15.

Cooperative conservation new policy, California Oil World, May 29.

Self-government in oil, Oil Bulletin, June.

A brief summary of the work done by the Geological Survey during the fiscal year is given in the following paragraphs:

GEOLOGIC WORK

Geologic work was done in 42 States and Alaska. In this work 13 of the States cooperated. The cooperative work takes a variety of forms but consists mainly of the study of specific problems on a cost-sharing basis. Considerable geologic work was also done in cooperation with other Government organizations and with nongovernmental scientific associations. Cooperative investigations bearing on oil and gas resources were made in 1 State, on metalliferous deposits in 4 States, on potash in 2 States, and on general geologic problems in 8 States. The investigations in search of potash, carried on in cooperation with the Bureau of Mines, were continued in New Mexico, where four sites for Government core drilling were selected, and in Texas, where drilling at four sites was completed. The cores were studied and selected portions analyzed, and preliminary reports on the economic results were prepared. Volcanologic studies were carried on in California, Alaska, and Hawaii. Numerous paleontologic determinations were made. Investigations of ore deposits, coal, oil shale, and other minerals and studies in glacial geology, stratigraphy, and structure were continued. In the chemical laboratory 5,880 samples of potash salts were examined and a total of 8,910 specimens were analyzed. Study and experimental work on ore deposition and other chemical problems were continued. Further work was done on problems connected with petroleum recovery.

EXPLORATIONS IN ALASKA

The principal explorations conducted by the Geological Survey in Alaska in the field season of 1928 were made in southeastern Alaska, the Copper River region, the Mount Spurr region of the Alaska Range, and the region north of the Tanana River. The work in southeastern Alaska consisted of reconnaissance-

sance topographic mapping in the Ketchikan district, with the aid of the aerial photographs taken by the Navy Department in 1928, and of a detailed survey of a small tract in the Juneau region for the Forest Service. The work in the Copper River region consisted of the revision of earlier geologic surveys in the Nizina district. The Mount Spurr expedition accomplished the topographic and geologic mapping of 1,000 square miles of new country. In the Tanana region the major geologic features of an area of nearly 4,000 square miles were mapped.

Six field projects were in progress at the end of the fiscal year 1929, including topographic studies in southeastern Alaska, in connection with the airplane photographing expedition of the Navy Department, geologic reconnaissance in the Copper River and Yukon-Tanana regions, and geologic and topographic reconnaissance in the Alaska Range. Some of the work in southeastern Alaska is being done for the Forest Service, which is bearing the cost. Special assistance is being given to the Alaska Railroad in solving problems that arise in its work in which geologic information is useful. The supervision of operations under leases issued by the Government for extracting coal and oil on public lands was continued during the year, a small staff being maintained at two local offices in Alaska for this purpose.

TOPOGRAPHIC MAPPING

The topographic work was done in cooperation with 25 States, county officials in 2 States, the War Department, the Corps of Engineers, and the Colorado Metal Mining Fund, and the area mapped amounted to 17,333 square miles in 29 States, the District of Columbia, and Hawaii. Of this total 12,966 square miles represents new surveys, 4,049 square miles resurveys, and 328 square miles revisions. The total area mapped to June 30, 1929, is 1,327,234 square miles. Nine States and the District of Columbia are now entirely mapped, and the percentages in other States range from 8 to 88.6. Of the total continental United States, exclusive of Alaska, 43.6 per cent has been mapped. River surveys amounting to 838 linear miles were also made. In connection with the topographic work 8,542 miles of spirit levels and 5,068 miles of transit traverse were run and 211 triangulation stations were occupied. Cooperation was continued with the Air Corps, United States Army, whereby aerial photographs were furnished for use in topographic mapping. A base map of California was prepared, and the base map of Arkansas was revised. A partial culture and drainage map of the Tensas Basin, Louisiana and Arkansas, was compiled for the Mississippi River Commission.

INVESTIGATIONS OF WATER RESOURCES

The work on water resources is done largely in cooperation with other Federal bureaus, with State, county, and municipal agencies, and with permittees and licensees of the Federal Power Commission. The amount expended by State, county, and municipal agencies for such work during the year, in part directly and in part through the Geological Survey, was \$367,929.66. This sum covered work in 35 States and Hawaii. Including the cooperative work, the study of surface waters, which consists primarily of the measurement of the flow of streams, was carried on in 47 States and Hawaii, in which at the end of the year 2,238 gaging stations were being maintained. The work on ground-water resources has been planned to meet the more and more exacting public demand for precise information with increasing need for the water. Investigations relating to ground water and power or reservoir sites were made in 22 States. Research into the principles of hydrology has been continued in order to provide a more secure basis for ground-water investigations. Cooperation was continued with well drillers' associations with a view to developing higher standards and better results in water-well drilling. The work on quality of water involved the examination of 1,037 samples of water and 245 samples of silt. The investigations of power resources included the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants.

WORK IN CLASSIFYING AND LEASING PUBLIC LAND

The work of classifying public and Indian lands with respect to mineral content and of supervising mineral operations on such lands was carried on in 21 States and Alaska. The number of cases involving land classification acted

on during the year was 15,428, and the results accomplished include net decreases of 57,006 acres in the area of outstanding coal withdrawals, of 92,140 acres in outstanding petroleum withdrawals, and of 26,261 acres in outstanding phosphate reserves. At the end of the year the total area classified as mineral in character amounted to 36,433,446 acres in 14 States and Alaska and the outstanding mineral withdrawals to 46,639,593 acres in 14 States. Definition of the "known geologic structure" of producing oil and gas fields was continued, and at the end of the year the net area so defined was 515,378 acres in seven States. Investigations to obtain information for classifying public land with respect to its value for the development of water power were made in four States. There was a net increase of 245,808 acres in the area included in power reserves, making a total of 6,479,570 acres in 20 States and Alaska, on which about 15,000,000 continuous horsepower can be developed. The net increase in enlarged-homestead designations was 142,493 acres, making a total outstanding of 325,302,286 acres in 14 States, and the net increase in stock-raising homestead designations was 1,141,957 acres, making a total outstanding of 120,236,561 acres in 18 States. There was a net increase of 15,040 acres in public water reserves, and the total outstanding is now 418,431 acres in 12 States. The supervisory work on public lands subject to the mineral leasing laws was increased by the issuance of 101 leases, 2,539 permits, and 13 licenses, covering 4,295,366.98 acres, and decreased by 8,756 cancellations of leases and permits. The production of petroleum on such lands during the year was 22,458,842.62 barrels, of natural gas 22,770,394,110 cubic feet, and of gasoline 47,319,874.32 gallons, on which the royalty, rentals, and bonuses amounted to \$3,685,883.35. The production of coal on such lands was 1,022,860.90 tons, of phosphate rock 21,792.06 tons, and of sodium 23,580.99 tons, on which the royalty, rentals, and bonuses amounted to \$414,186.11. Supervision over oil and gas operations on naval petroleum reserves was continued, and the production was 8,116,635.98 barrels of petroleum, 7,711,858,000 cubic feet of natural gas, and 24,908,262.82 gallons of gasoline, on which the royalty value was \$1,817,464.45. Inspectional, regulatory, and advisory service was rendered in connection with the leasing of mineral deposits on Indian lands in seven States, with a royalty value of approximately \$7,500,000, nearly all in Oklahoma.

PUBLICATIONS

The publications of the year consisted of 60 books and pamphlets of the regular series, 76 new or revised maps, 200 reprinted maps, and numerous circulars, lists of publications, etc. The total number of pages in the new book publications was 7,381. In addition to the publications in the regular series, 89 brief reports were issued in mimeographed form as memoranda for the press. The manuscript edited and prepared for printing amounted to 16,601 pages; 2,677 galley proofs and 14,814 page proofs were read and corrected. Indexes were prepared for 31 publications, covering 6,291 pages. The drawings prepared for publications numbered 2,738, and the proofs of illustrations examined 969. The new topographic maps edited and transmitted for engraving numbered 57, and 473 other maps were edited. Map proofs numbering 600 were read. Of new and reprinted maps and folios 759,732 copies were printed. The publications distributed numbered 975,155, of which 8,910 folios and 717,349 maps were sold for \$49,289.38.

GEOLOGIC BRANCH

W. C. MENDENHALL, *Chief Geologist*

ORGANIZATION AND PERSONNEL

The work of the geologic branch has been administered during the year through 10 units, representing topical or geographic groupings of activities. These units are as follows:

Paleontology and stratigraphy, T. W. Stanton, geologist, in charge.
 Geology of metalliferous deposits, G. F. Loughlin, geologist, in charge.
 Geology of areal and nonmetalliferous deposits, G. R. Mansfield, geologist, in charge.
 Geology of iron and steel metals, E. F. Burchard, geologist, in charge.
 Glacial geology, W. C. Alden, geologist, in charge.

Coastal Plain investigations, L. W. Stephenson, geologist, in charge.
 Geology of fuels, H. D. Miser, geologist, in charge.
 Volcanology, T. A. Jaggar, jr., volcanologist, in charge.
 Petrology, C. S. Ross, geologist, in charge.
 Chemistry and physics, George Steiger, chemist, in charge.

The professional force was reduced by 1 retirement, 5 transfers (including 2 topographic engineers), and 1 resignation, and there were 14 appointments (including 1 topographic engineer). With these changes it now includes 106 geologists of various grades, many of whom are not employed continuously, 8 chemists, and 2 physicists. The subprofessional force comprises 6 draftsmen (2 temporary), 7 preparators of fossils (1 temporary), and 1 laboratory mechanic. In the clerical force there were 5 accessions and 9 separations, leaving a total of 27 clerks of various grades, 2 of whom are temporary.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the geologic branch for the fiscal year were as follows:

Geologic surveys	\$355, 000
Classification of lands	18, 000
Volcanologic surveys	21, 000
Investigating potash deposits	10, 000
Repayments from other Federal departments	7, 647
Repayments from State, city, and other cooperating organizations	22, 468
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	434, 115

The expenditures from these funds may be classified approximately as follows:

Geologic investigations (economic and scientific)	\$323, 142
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc	91, 191
Hawaiian volcanology	18, 526
Unexpended balances	1, 256
	<hr/>
	434, 115

NEED FOR GEOLOGIC RESEARCH

The student of modern civilization, its trends and the reasons that underlie its swift advance, finds it difficult to phrase a plea for the support of research—as difficult as to prove an axiom; to him no plea is needed. Research, resulting in an understanding of natural laws and of man's relation to nature, is the very foundation of modern life. This understanding constitutes perhaps the most essential difference between the brilliant civilizations of the past and those of to-day and contains the soundest basis for expecting that those of to-day will survive, although those of the past have perished. Research has substituted an alliance with nature for war with nature. In art, in philosophy, in literature we may still be the pupils of the past. But in science and its applications we are in a new era. In this field antiquity has nothing to compare with the present.

Science itself has developed with democracy. The release of the human mind from the bondage of ignorance by the Revival of Learning, the spread of education that followed, the destruction of the spirit of feudalism, the recognition of the value and the rights

of the individual are all steps in the process through which the modern state has evolved. This evolution has released and developed the latent intellectual powers of the masses of mankind and enlisted them in the service of further progress. It is in the atmosphere thus created that science has developed. Because self-government, political and intellectual freedom, universal education, and scientific progress are characteristics of the modern state, are interdependent, and advance together, all must be fostered if the advance is to continue. Research, the basis of scientific progress, is no less important than the others. Upon it depends man's mastery of nature, the multiplication of his physical powers, and his release from deadening drudgery, and it is perhaps the greatest of modern stimuli to his intellectual development, through its constant revelation of new facts and new relations and its constant calls upon his powers of constructive imagination.

Among modern States, those that lead in supporting and fostering educational and scientific progress also lead in political and intellectual progress. In such States material prosperity need not be made a matter of direct concern. It is an inevitable by-product of this leadership. It follows scientific and educational progress as surely as day follows night.

Because research in the sciences is thus an integral part of modern human progress, it should be unnecessary to urge support of research by a modern State. That should be and eventually will be recognized as one of its every-day duties to its citizens—as direct a duty and as unnecessary of specific advocacy as national defense or education.

Not only because geology is one of the sciences but also because it is one of those upon which each citizen depends daily and hourly, whether he realizes it or not, its study should have adequate national support. All the metals, the important fuels, the more permanent building materials, the soils are geologic products—parts of the earth's crust. Imagine a world without steel, copper, aluminum, coal, petroleum, concrete. It would be a world without railroads, automobiles, airplanes, telephones, telegraph, electric power and light—in short, without modern communication, transportation, or industry; industrially we would be living in the Middle Ages.

Through force of circumstances, chiefly financial, an undue proportion of the energies of the geologic branch in recent years has been directed into the fields of applied geology. This does not mean that no research work has been done. It means merely that not enough of it has been done. No scientific organization, even though much of its energy must be devoted to the application of science, can continue to function long without continuing the study of principles. Research is to such an organization what fuel is to the engine or food to the body. It is the source of power. If a continuous supply is not maintained, the mechanism runs down. For this reason research has been maintained, along with that work which is commonly denominated practical, because it is directed immediately to supplying an answer to some question of current human need. More coal, or copper, or manganese, or potash, or granite is wanted. Where is it to be found? How accessible is it? What is its quality? Is it suited to the specific need? But none of these questions can

be answered adequately unless there have been years of study quietly conducted before the need arises, to determine where the substances are to be expected, what differences exist in distribution and in quality in different localities, and why.

So geologic research has continued of necessity, as well as of choice, while the practical work has been going forward. Each study of a practical question has been made the vehicle to carry some research into principles. It has yielded its bit of knowledge about heretofore unknown facts and relations. Any thorough study of a problem by trained men will yield such contributions. But too much of the research during the last decade or two has been of this incidental sort. Too little of the work has been specifically planned and directed for the purpose of finding out more about unknown general relations and natural laws. As a consequence of this enforced relative neglect of fundamental work in geology, its capacity to solve the growing volume of practical problems, which are constantly increasing in complexity, is being endangered. The immediate need is to strengthen our foundations, to add to the staff of research workers, to increase the energy available for fundamental work. To apply science to human needs, there must be science to apply. Research can not be neglected in any field of science, geologic or other, without jeopardizing its usefulness.

It is high time that this principle should be publicly recognized and adequate support be forthcoming for those phases of geologic work which, although their application to current problems may not be obvious, constitute the foundations for future usefulness. Secretary Wilbur has recently said, "So close to-day is the link between science and its laboratories and the Government that we can measure the progress of a civilization by its economic capacity to support laboratories and by the quality of the intellects brought into them." Will our civilization meet this test?

WORK IN GEOLOGY BY STATES

ALABAMA

An examination of lands in the Pearson Hills unit and a report thereon was made by O. W. Cooke for the Forest Service. Deposits of iron ore in Jackson, Cullman, Marshall, De Kalb, Etowah, Cherokee, St. Clair, and Calhoun Counties were examined by E. F. Burchard in cooperation with the Alabama Geological Survey. A report on the red iron ores of northeastern Alabama, giving the results of this work, will be published by the State.

ALASKA

The seismograph station at Kodiak was in operation for a part of the year, and a station was established at Dutch Harbor, where the construction of the hut and the installation of the seismograph were in charge of Austin E. Jones.

ARIZONA

Further field paleontologic examinations of the Hermit shale and the Supai formation of the Grand Canyon, determination of the stratigraphic limits of the Redwall and the Cambrian formations in the same section, and a search for remains of pre-Cambrian life in the formations of the Unkar group in the vicinity of Bright Angel Creek were made by David White. A manuscript describing and illustrating the fossil plants of the Hermit shale was transmitted for publication to the Carnegie Institution, which has supported the cost of the field investigations and travel. The Apache group in central

Arizona was examined by Mr. White at a number of points for traces of fossil remains, and the Devonian, Mississippian, and Carboniferous stratigraphy in the region embracing Puyson and Jerome was inspected in a review of the stratigraphic work by Prof. A. Stoyanow, of the Arizona State University. A paper on correlation of the Permian of southern Utah, northern Arizona, northwestern New Mexico, and southwestern Colorado was prepared by A. A. Baker and J. B. Reeside, Jr., to be published in the Bulletin of the American Association of Petroleum Geologists. A paper on the Cretaceous section in Black Mesa, northeastern Arizona, was submitted by Messrs. Reeside and Baker for publication in the Journal of the Washington Academy of Sciences. On invitation of the Carnegie Institute, N. H. Darton spent several days at the Grand Canyon for the purpose of investigating conditions under which the geologic features might be made of interest to the public. A geologic map of the Grand Canyon was prepared by Mr. Darton and transmitted to the National Park Service for use in the Museum at Yavapai Point. He also prepared a description of the geology of Arizona for publication in the North American volume of *Geologie der Erde*.

A manganese deposit at Bisbee was examined by D. F. Hewett, in connection with a summary of manganese ore deposits of the United States for which Mr. Hewett is accumulating material. A strontium deposit near Agulla was examined by B. S. Butler, who prepared a brief report describing it as a memorandum for the press. A large deposit of iron ore near the west line of the Fort Apache Indian Reservation was examined and a local map prepared by E. F. Burchard and B. W. Dyer, at the request of the conservation branch. A report on nitrate deposits of the Southwest, prepared by L. F. Noble, contains brief notes on deposits in the Peloncillo Mountains of southeastern Arizona.

ARKANSAS

A tract of land adjacent to the Ouachita National Forest in west-central Arkansas was examined by H. D. Miser at the request of the Forest Service, and a report was prepared and transmitted to that service. Additional stratigraphic and structural studies in parts of the Ouachita Mountains of Oklahoma and Arkansas were made by Mr. Miser, in company with C. L. Cooper, of the Oklahoma Geological Survey, and a paper on the structure of the Ouachita Mountains of Oklahoma and Arkansas was transmitted to the Oklahoma Survey for publication. In informal cooperation with the Arkansas Geological Survey work was contributed by several members of the branch toward the completion of the new geologic map of Arkansas to be issued by the State. The study of the lead and zinc deposits of northern Arkansas was continued by E. T. McKnight in cooperation with the Arkansas Geological Survey. E. O. Ulrich reported on Paleozoic invertebrate fossils from this area. Studies of the Carboniferous invertebrate faunas of the Morrow formation and the Batesville sandstone and of the faunas of the basal Fayetteville shale were continued by G. H. Girty. Pleistocene mollusks were reported on by W. C. Mansfield, and a study of upper Mississippian invertebrates was made by P. V. Roundy. Manganese deposits of the Batesville district were examined by Mr. Miser. A note on the age of the Brownstown marl of Arkansas was submitted by L. W. Stephenson for publication in the Bulletin of the American Association of Petroleum Geologists.

Publication: Professional Papers 154-B and 154-F. (See p. 3.)

CALIFORNIA

Studies of the Engels-Walker copper belt, in Plumas County, were completed by Adolph Knopf, who is now preparing the report on this investigation. Recent developments in the Allegheny mining district were studied by H. G. Ferguson, who completed the revision of his report on that district. A paper on the gold-quartz veins of the Allegheny district, by Mr. Ferguson and R. W. Gannett, was presented at the meeting of the American Institute of Mining and Metallurgical Engineers in New York in February and published by that organization as Technical Paper 211.

Manganese deposits in Plumas, San Joaquin, and San Luis Obispo Counties were examined by D. F. Hewett in connection with a summary of manganese ore deposits of the United States. F. E. Matthes completed the final revision of his report on the Yosemite Valley, to be published as a professional paper.

and revised the descriptive text for the back of the Yosemite Valley topographic map. He also prepared a short paper entitled "Multiple Glaciation in the Sierra Nevada," which was published in *Science*, July 10, 1929. A report on the geology of the eastern part of the Santa Monica Mountains and adjacent areas, Los Angeles County, was completed by H. W. Hoots, to be published in "Shorter contributions to general geology." Papers on the age of the Modelo formation of the Santa Monica Mountains and on warm-water faunas of the so-called Pliocene of San Pedro were presented by W. P. Woodring at the meeting of the Cordilleran section of the Geological Society of America, and abstracts were published in the proceedings of the meeting.

The report on the Elk Hills oil field is being revised by Mr. Woodring, P. V. Roundy, and H. R. Farnsworth.

Studies of the San Andreas rift in the Cajon Pass area were continued by L. F. Noble, who made much progress on his report on the rift zone. Mr. Noble also completed and submitted his report on nitrate deposits of southeastern California. A paper by W. T. Schaller on borate minerals from the Kramer district, Mohave Desert, was approved for publication as Professional Paper 158-I. An area covered by the Mount Diablo overthrust in the Mount Diablo, Concord, Byron, and Napa quadrangles was inspected by G. R. Mansfield in company with B. L. Clark and C. E. Weaver in connection with reports in preparation by Messrs. Clark and Weaver. Mr. Mansfield also examined diatomite deposits on the Pit River, northeastern Shasta County. The Lassen Volcano Observatory, one of the stations maintained for the studies of volcanology, has been conducted by R. H. Finch. A paper on the quartz basalt eruptions of Cinder Cone, Lassen Volcanic National Park, was prepared by Mr. Finch and C. A. Anderson for publication either by the University of California or in the *American Journal of Science*.

Publications: Professional Papers 154-E, 157. (See p. 3.)

COLORADO

Cooperative geologic work with the State of Colorado and the Colorado Metal Mining Fund in a study of the mining geology of the State was continued under the immediate supervision of B. S. Butler. Mr. Butler, assisted by Q. D. Singewald, spent most of the field season in a detailed study of the Alma district and vicinity, on the east slope of the Mosquito Range. With W. S. Burbank he completed a paper on the electrode potential of some elements of hypogene mineral deposits, which was published by the American Institute of Mining and Metallurgical Engineers. Mr. Butler also completed a preliminary paper on the relation of ore deposits in the Rocky Mountains to the Colorado Plateau, to be published by the Colorado Scientific Society. A detailed study of the west slope of the Mosquito Range in areas adjoining the Leadville district on the south was begun by C. H. Behre, who has transmitted a brief paper showing certain results of interest to the mining industry, to be published by the Colorado Scientific Society. A paper on edge facies of mineralization at Leadville was presented by Mr. Behre before the Ohio Academy of Science, and an abstract of this paper will be published in the *Ohio Journal of Science*. G. F. Loughlin spent a few days in Cripple Creek visiting mines that were not accessible during previous visits. Work in the Bonanza district was completed by Mr. Burbank, and he then began a resurvey of the Ouray district. A preliminary report on the Bonanza mining district has been issued as a press memorandum, and the complete report will be transmitted during the summer of 1929. Mr. Burbank has also prepared a short paper for the benefit of mining interests showing the position of ore horizons in sedimentary rocks in the Ouray district. Work in the Breckenridge district was completed by T. S. Lovering, who continued structural and stratigraphic studies in the mineralized belt of the Front Range from Breckenridge northeastward. His work thus far has covered about four 15-minute quadrangles in considerable detail and includes related reconnaissance in adjoining areas. His report on the Breckenridge district will probably be transmitted in the summer or fall of 1929; his paper on the geologic history of the Front Range was completed, and a report on the Montezuma quadrangle is well under way. In the Washington office M. N. Short continued his microscopic studies of ores from the several districts, Edwin Kirk determined Ordovician invertebrate fossils for Messrs. Behre and Burbank, and J. B. Reeside, Jr., reported on Cretaceous invertebrate fossils from central Colorado for Mr. Lovering. A report on recent mining developments in the Creede dis-

trict, by E. S. Larsen, was completed and transmitted for publication as Bulletin 811-B. A comprehensive report on the volcanic and other rocks of the entire San Juan region of southwestern Colorado is being prepared by Mr. Larsen, for whom map data on the Ignacio and Red Mesa quadrangles were assembled by J. B. Reeside, jr. A paper on the physiography and Quaternary geology of the San Juan Mountains, by W. W. Atwood and K. F. Mather, has been transmitted for publication as a professional paper. Quarries and drifts made by oil-shale companies near Rifle and DeBeque were examined by David White, who collected specimens for research investigations. A report on the origin and microfossils of the oil shale of the Green River formation of Colorado and Utah was completed by W. H. Bradley and transmitted for publication as a professional paper, and a paper on the varves and climate of the Green River epoch, by Mr. Bradley, will be published as Professional Paper 158-E. A report on the geology and coal resources of the Book Cliffs field, Garfield and Mesa Counties, was completed by C. E. Erdmann, and progress was made by M. R. Campbell on his report on the coal resources, structure, and stratigraphy of the eastern Yampa coal field. Mr. Lovering examined the Granby anticline, in Grand County, and prepared and transmitted for publication in Contributions to Economic Geology a report on this investigation. A granite quarry near Salida was examined by G. F. Loughlin. A paper on correlation of the Permian of southern Utah, northern Arizona, northwestern New Mexico, and southwestern Colorado was prepared by A. A. Baker and J. B. Reeside, jr., for publication in the Bulletin of the American Association of Petroleum Geologists. Carboniferous invertebrates were studied by G. H. Girty, who spent a short time in field work in the State.

Publications: Professional Papers 154-G, 154-J, 158-A. (See p. 3.)

CONNECTICUT

In connection with studies in the southern Taconic area, which included detailed areal mapping in the Clove quadrangle, New York, Mrs. E. B. Knopf did occasional reconnaissance mapping in the Cornwall and New Milford quadrangles.

FLORIDA

The report on the geology of Florida, with accompanying geologic map of the State, by C. W. Cooke and Stuart Mossom, prepared in cooperation with the Florida Geological Survey, has been published by the State. Mr. Cooke presented a paper on the geology of Florida at the December meeting of the Geological Society of America, and an abstract of the paper was published in the bulletin of that society. A cooperative report on the Miocene gastropods and scaphopods of the Choctawhatchee marl of northwestern Florida was completed by W. C. Mansfield and transmitted to the Florida Geological Survey for publication. Mr. Mansfield also has in preparation a report on the pelecypods of the Choctawhatchee marl. Localities in Walton County reported to contain fluorspar deposits were examined by E. F. Burchard.

GEORGIA

A field study of the Tertiary formations of the Coastal Plain of Georgia was made by C. W. Cooke for the purpose of establishing closer correlations with the adjacent States and of obtaining data for a revised geologic map of the State.

HAWAII

From the headquarters of the section of volcanology at Hawaiian Volcano Observatory, Hawaii National Park, T. A. Jaggar, jr., directed the work of the Hawaiian, Lassen (Calif.), and Alaskan stations. In the Hawaiian Islands the work consisted of observations of Halemaumau, including mapping of changes, the operation of a seismograph on the edge of the pit, and measurement of rim fissures; the operation of seismographs at Mauna Loa, at Kilauea Station, and at Uwekahuna, on the west summit of Kilauea Mountain; measurements of seismograms and preparation of seismologic reports; recording of tide data from Ilio and Honolulu gages; and designing, building, and repairing seismographs and other instruments. Cooperation with the Hawaiian Volcano Research Association was continued in the publication of the Weekly

Volcano Letter and the Monthly Bulletin, in inspection and direction of the sesimograph stations at Hilo and Kealukekua and temperature bore holes, in collaborative experimental projects, and in the direction of research associates.

IDAHO

Continued field studies of the geology, geography, and mineral resources of southeastern Idaho were carried on in the Ammon quadrangle by G. R. Mansfield, assisted by W. B. Lang, who also reviewed some details in mapping in the Paradise Valley quadrangle and made a trip to the Continental Divide west of Spencer and to the Snake River Plains in company with H. T. Stearns to study problems of overthrusting and rhyolitic extrusion. A report on the geography, geology, and mineral resources of the Portneuf quadrangle, by Mr. Mansfield, was published as Bulletin 803. A paper on the Blackfoot Mountains was prepared by Mr. Mansfield for presentation to the Geological Society of Washington. A reconnaissance study of the glacial geology and physiography of parts of Bonner, Kootenai, Fremont, and Teton Counties was made by W. C. Alden, and the results will be incorporated in a report on the glacial geology and physiography of western Montana, eastern Washington, and northern Idaho. In continuation of his studies of the ore deposits of south-central Idaho, C. P. Ross did geologic mapping and examined mines of the Bayhorse quadrangle and made a trip to the Wood River district to review recent developments. Mr. Ross completed a report on the geology and mines of the Casto quadrangle and a paper on the history of mining in central Idaho. He has in preparation reports on the Bayhorse quadrangle and on south-central Idaho as a whole. A paper entitled "A Resurrected Fossil Forest in Idaho" was prepared by Mr. Ross for publication in the Idaho School of Mines Quarterly. A paper on early Pleistocene glaciation in central Idaho was prepared and transmitted by Mr. Ross for publication as Professional Paper 158-G, and a section on the gold resources of Idaho was submitted by Mr. Ross in preliminary form for inclusion in a report on gold resources of the United States to be presented at the meeting of the International Geological Congress at Pretoria, South Africa, in August, 1929. Fresh-water Tertiary mollusks were identified by W. C. Mansfield, and Silurian and Ordovician invertebrates were examined by Edwin Kirk. Carboniferous invertebrates were studied by G. H. Girty. Work was continued on a report by D. F. Hewett on the Mineral Hill section of the Wood River district. The cooperative report on the geology and silver ore deposits of the Pend Oreille district, by Edward Sampson, was transmitted for publication by the Idaho Bureau of Mines and Geology. A paper on contact metamorphism of the rocks of the Pend Oreille district, by J. L. Gillson, was submitted for publication as Professional Paper 158-F. C. H. Behre, jr., prepared a report on Tertiary volcanic tuffs and sandstones used as building stones in the upper Salmon River Valley for publication in Contributions to Economic Geology.

ILLINOIS

The geologic mapping of the Hardin and Brussels quadrangles, a cooperative project with the Illinois Geological Survey, was continued by W. W. Rubey, who made some progress in the preparation of the report on these quadrangles. G. B. Mansfield made a brief inspection trip through this area with Mr. Rubey. Supposed Pleistocene plants from the area were reported on by E. W. Berry, and Ordovician and Silurian invertebrates were studied and reported on by E. O. Ulrich. Field examinations of sections of Pottsville age and collections of fossil plants for monographic study were made by David White, in cooperation with the Geological Survey of Illinois. The projected report is planned for publication by the State. A geologic folio on the Equality and Shawneetown quadrangles was revised by Charles Butts. The study of the Carboniferous invertebrates of the Ste. Genevieve and Okaw formations was continued by G. H. Girty.

INDIANA

A report on Indiana oolitic limestone and the relation of its natural features to its commercial grading was revised by G. F. Loughlin and transmitted for publication as Bulletin 811-C. This work was undertaken in 1917 by agreement with the Director of the Bureau of Standards and the Supervising Architect. An abstract of the paper was read before the American Institute of Mining and Metallurgical Engineers in New York, February, 1929.

IOWA

An article on the Loveland loess, discussion of a paper by G. F. Kay, was prepared by Frank Leverett for publication in Science.

KANSAS

A cooperative report on the geology of Cowley County, with special reference to the occurrence of oil and gas, by N. W. Bass, was transmitted to the Geological Survey of Kansas for publication. Pennsylvanian and Carboniferous invertebrates and Carboniferous microfossils were studied by P. V. Roundy, and collections of fossil plants, vertebrate skulls, and invertebrates at Baldwin were inspected by David White.

KENTUCKY

A geologic folio on the Equality and Shawneeton quadrangles, lying partly in Kentucky, was revised by Charles Butts.

LOUISIANA

Lands in the Kisatchie and Vernon areas were examined by C. W. Cooke at the request of the Forest Service, to which a report was made. Revision of the oil and gas map of Louisiana was undertaken by G. B. Richardson, who made a field trip to obtain additional data. Well cores in the offices of oil companies at Shreveport were studied by W. P. Popenoe.

MARYLAND

Work in field and office was continued by Miss A. I. Jonas, in connection with the report on Frederick County and revision of the report on Baltimore County, for publication by the Maryland Geological Survey in informal cooperation with the United States Geological Survey. Field work was done in Frederick County and the eastern part of Washington County by G. W. Stose in cooperation with the Maryland Geological Survey, which is to publish reports on these counties.

MASSACHUSETTS

The structural relations of Greylock Mountain and adjoining areas in the Taconic quadrangle were studied by L. M. Prindle, and special localities in the Berlin and Greylock quadrangles were visited by Mr. Prindle in company with G. R. Mansfield. Mr. Prindle extended these studies to the Pittsfield quadrangle. Progress was made by Mr. Prindle on his report covering these investigations.

MISSISSIPPI

Lands in the Homochitto and Pearson Hills area were examined by C. W. Cooke for the Forest Service, to which a report was made. Cuttings from an oil prospecting well near Amory were studied by L. W. Stephenson and Charles Butts. A small collection of fossil plants from the Mississippian formation of northeastern Mississippi was examined by David White. W. P. Popenoe visited the offices of oil companies at Meridian and Jackson to study well cores as an aid in general studies of stratigraphy and correlation.

MISSOURI

The Missouri-Arkansas field conferences of the Kansas Geological Survey at Cape Girardeau and Ste. Genevieve were attended by W. W. Rubey, who also conferred with other geologists on Mississippian problems near the Hardin and Brussels quadrangles. The Lafayette gravel of St. Louis County formed the subject of a conference by Mr. Rubey with E. D. Shipton, and Mr. Rubey also conferred with the State geologist of Illinois regarding the Pleistocene near Winfield. The lead and zinc mines of the Joplin region were visited by E. T. McKnight. Carboniferous invertebrates were studied in the field and office by G. H. Girty, early Paleozoic invertebrates by E. O. Ulrich, and Carboniferous microfossils by P. V. Roundy.

MONTANA

The mapping of the lignite resources of McCone and Dawson Counties, with stratigraphic, structural, and physiographic studies, was continued in 1928 by A. J. Collier and C. E. Erdmann and in 1929 by Mr. Collier, assisted by M. N. Bramlette, M. P. Billings, H. E. Thomas, and Frank S. Parker. Progress on a report on the investigations of 1928 was made by Mr. Collier. Field studies and mapping of the Ashland coal field of Powder River County and adjacent parts of Rosebud and Custer Counties were completed by a party under the direction of N. W. Bass, who completed a report on the geology of the field. A detailed examination of the Lance, Lebo, and Fort Union coals in parts of Rosebud and Custer Counties along Tongue River, a northward extension of Mr. Bass's work of 1928, was begun by A. A. Baker, assisted by William G. Pierce and R. W. Brown. In connection with the revision of a report on the geology of the Crow Indian Reservation, W. T. Thom, jr., spent a few days in checking the areal geology and rock correlations in parts of that reservation. In cooperation with the city of Helena, the study of the mining districts in the greater Helena mining region, begun two years ago, was broadened to include a large area south of Helena and an area in the Belt Mountains between York and Confederate Gulches. The work in the York-Confederate Gulch area was carried on by J. T. Pardee, assisted by Russell Gibson, and that in the area south of Helena, near Winston and Deer Lodge, by F. C. Schrader. A preliminary report on the metalliferous deposits in the York-Confederate Gulch area, by Mr. Pardee, has been issued as a memorandum for the press, and a preliminary report on the metalliferous deposits in the Winston-Deer Lodge area, by Mr. Schrader, will be issued shortly in similar form. An investigation of the mining districts of the Libby quadrangle was begun by Mr. Gibson under the general supervision of Mr. Pardee. Deposits of manganese ore at Phillipsburg, Canyon Ferry, and Deer Lodge were examined by Mr. Pardee, who is preparing a short report on manganese reserves at Phillipsburg and has in preparation a paper on late Tertiary and Quaternary faults in southwestern Montana. Reconnaissance field studies of the glacial geology and physiography of western Montana were extended by W. C. Alden to parts of Lincoln, Flathead, Missoula, Ravalli, Beaverhead, and Madison Counties and Glacier National Park. The report on glacial geology and physiography of eastern Montana was revised by Mr. Alden, who also made progress on a report on physiography and glacial geology of western Montana, northern Idaho, and eastern Washington and a report on Glacier National Park. A report on the geology of the Big Snowy Mountains was completed by Frank Reeves, for publication in *Shorter Contributions to General Geology*. Devonian invertebrates from an oil well in Montana were reported on by Edwin Kirk for the Montana Bureau of Mines. Carboniferous invertebrates were studied by G. H. Girty, and Cretaceous invertebrates by J. B. Reeside, jr., and T. W. Stanton. A stratigraphic section and well log measured in Blaine County and submitted by C. L. Thompson were studied by Mr. Reeside.

Publications: Bulletins 805-B, 806-B, and 806-E. (See p. 3.)

NEBRASKA

Carboniferous invertebrates were studied by G. H. Girty.

NEVADA

Studies in the Ivanpah quadrangle were continued by D. F. Hewett and in the Tonopah and Hawthorne quadrangles by H. G. Ferguson, who also began investigations in the Lowry Peak quadrangle and a study of the geology and ore deposits of the Silver Peak quadrangle. Progress was made on the reports on the geology and ore deposits of the Tonopah and Hawthorne quadrangles by Mr. Ferguson, of the Carson Sink by F. C. Schrader, and of the Ivanpah quadrangle by Mr. Hewett. The report on the geology and ore deposits of the Goodsprings quadrangle by Mr. Hewett has been transmitted for publication as a professional paper, and a paper on the mining districts of Nevada by Mr. Ferguson was completed and published in *Economic Geology*, March-April, 1929. Two brief papers on petrography of the Pioche district were submitted by J. L. Gillson for publication as Professional Paper 158-D. A study of rock alteration in Nevada was made by G. F. Loughlin and Mr. Hewett, and examinations in the Ely, Hamilton, and Eureka districts were made by Mr. Hewett in connection with his study of dolomitization. A manganese mine east of

Las Vegas was examined by Mr. Hewett. Field studies of the Carboniferous formations of the Eureka district and the Las Vegas quadrangle were continued by G. H. Girty in cooperation with Mr. Ferguson and C. R. Longwell. Office studies of the collections of Carboniferous invertebrates were made by Mr. Girty and P. V. Roundy. A small collection of upper Paleozoic plants obtained by Messrs. Girty and Ferguson was examined by David White. Stratigraphic studies of the Cambrian, Ordovician, Silurian, and Devonian formations were made in the vicinity of Eureka, in the White Pine district, and in the Lowry Peak quadrangle, by Edwin Kirk, in cooperation with Mr. Ferguson, and office studies of collections of Ordovician and Devonian invertebrates were made by Mr. Kirk. Middle Triassic ammonites were identified by T. W. Stanton for the National Museum.

Publication: Bulletin 798. (See p. 3.)

NEW HAMPSHIRE

A visit to the White Mountains to determine the upper limits of the Wisconsin ice sheet was made by Frank Leverett in company with Dr. Ernst Antevs.

NEW JERSEY

Results of studies of the pre-Wisconsin glacial and associated deposits in New Jersey, in which the New Jersey Geological Survey cooperated, will be embodied in a paper by Frank Leverett to be published by the Pennsylvania Topographic and Geologic Survey. Fossil material from the Shiloh marl was collected and studied by W. C. Mansfield, in connection with his general studies of the Miocene formations of the Atlantic Coastal Plain.

NEW MEXICO

The search for potash was continued in the Permian salt basin of southeastern New Mexico and western Texas. W. B. Lang was assisted in the field office at Roswell, N. Mex., by J. W. Vanderwilt during the first part of the year and by R. K. Bailey later. Mr. Lang kept in close touch with drilling operations in this area and so far as possible obtained samples for potash testing from all wells being drilled in the area. He also obtained for study by the Geological Survey portions of cores from special tests for potash made in Eddy County by two private companies. Four sites in Eddy, Lea, and Chaves Counties were recommended for Government potash tests to be made during the next fiscal year under the supervision of the Bureau of Mines. Mr. Vanderwilt made logs of wells being drilled in southeastern New Mexico and began a structure map of that area showing the top of the salt series. Mr. Bailey's time was devoted chiefly to the logging of samples and the making of potash tests. A press notice entitled "Potash Struck by Three More Government Tests in Texas," which included information relative to potash findings in wells drilled for oil in New Mexico, was prepared by G. R. Mansfield. A paper on Government potash exploration in Texas and New Mexico was prepared by Messrs. Mansfield and Lang, presented at the meeting of the American Institute of Mining and Metallurgical Engineers in New York in February, and published by the Institute as Technical Publication 212. A paper on the mineralogy of the potash field of New Mexico and Texas was presented by W. T. Schaller at the same meeting. Studies in the Jemez Mountains were completed by C. S. Ross and E. S. Larsen, and some progress was made on the report on the igneous geology of the area. G. F. Loughlin visited the Magdalena mining district with members of the New Mexico Bureau of Mines and Geology and supplied them with a geologic map and other data for a report on the geology and ore deposits of the district. Geologic mapping and study of the ore deposits of the Santa Rita quadrangle were resumed by A. C. Spencer, who revised topographic mapping where necessary and continued preparation of his report on the district. Upper Cretaceous invertebrates from this quadrangle were identified by T. W. Stanton. Structural and stratigraphic studies of the coal-bearing and associated formations on the south side of the San Juan Basin in northeastern McKinley County and northwestern Sandoval County were continued by C. H. Dane and party, and the manuscript of a report on the geology and coal resources of this region, by Mr. Dane, is in progress. Field work in northwestern New Mexico, northeast of Gallup, for the purpose of mapping the coals of the Mesaverde formation, was begun by J. D. Sears and party in the

spring of 1929. The work will consist of an extension northeast and east of the work of Mr. Sears in the Gallup district in 1919-20 and will eventually connect on the east with the work of the party in charge of Mr. Dane in 1923. A reconnaissance of a part of northern New Mexico was made by A. A. Baker and J. B. Reeside, jr., in connection with Utah studies, and a paper on correlation of the Permian of southern Utah, northern Arizona, northwestern New Mexico, and southwestern Colorado, by Messrs. Baker and Reeside, was transmitted for publication in the Bulletin of the American Association of Petroleum Geologists. Preparation of a paper on the fauna of the Lake Valley limestone was continued by G. H. Girty, who also continued in field and office his studies of other Carboniferous invertebrates. Land shells, probably of Pleistocene age, from northeastern New Mexico were identified by W. C. Mansfield. Manganese deposits near Deming, Santa Rita, Silver City, Lordsburg, and Rodeo were examined by D. F. Hewett. The report on the nitrate deposits of the Southwest by L. F. Noble includes a description of nitrate claims in the Animas Valley, N. Mex. N. H. Darton prepared a chapter on the geology of New Mexico for publication in the volume on North America of *Geologie der Erde*.

Publications: Geologic map of New Mexico, on a scale of 1:500,000; Bulletin 794. (See p. 3.)

NEW YORK

The study of structural relations in the Taconic quadrangle, which includes the Berlin and Hoosick quadrangles in New York, was continued by L. M. Prindle, and an inspection trip by Mr. Prindle and G. R. Mansfield extended into the Cambridge quadrangle. In the office Mr. Prindle continued work on geologic maps and text of the report on this area. Areal mapping of parts of the Clove, Millbrook, and Poughkeepsie quadrangles was continued by Mrs. E. B. Knopf, who made petrographic and other studies pertaining to the proposed report on this area. Primary structural features of igneous bodies in the Adirondack Mountains near Lake Placid were studied by James Gilluly in cooperation with Prof. Robert Balk, a specialist on the subject. The upper limit of Wisconsin glaciation in the Catskill Mountains was studied by Frank Leverett, assisted by Ernst Antevs, in company with George H. Chadwick. Stratigraphic sections in eastern New York were studied by E. O. Ulrich with members of the New York State Survey.

NORTH CAROLINA

A field examination of the upper Miocene deposits of North Carolina was continued by W. C. Mansfield, and the material collected was studied in the office. Mr. Mansfield also prepared a paper on some deep wells near the Atlantic coast in Virginia and the Carolinas for publication in the Proceedings of the Geological Society of Washington.

NORTH DAKOTA

Cretaceous invertebrates were identified by J. B. Reeside, jr., for the North Dakota Historical Society at the request of the National Museum. The results of Mr. Reeside's studies of cuttings from the Glenfield well, eastern North Dakota, were published in a memorandum for the press.

Publications: Bulletins 775, 801. (See p. 3.)

OHIO

Preparation of a report on the glacial geology, physiography, and drainage history of the upper Ohio Valley, embracing parts of Ohio, West Virginia, and western Pennsylvania, for publication as a professional paper, was continued by Frank Leverett.

OKLAHOMA

Work on a report on the lead and zinc deposits of the Picher and Miami areas, in the Wyandotte quadrangle, was continued by C. E. Siebenthal. Carboniferous invertebrates were studied by G. H. Girty, who also continued preparation of his reports on the faunas of the Morrow, Moorfield, and Glenn formations. Carboniferous microfossils were studied by P. V. Roundy. Ordovician and older Paleozoic formations were studied by E. O. Ulrich, in cooperation with

C. H. Decker, of the Oklahoma Geological Survey. A paper entitled "Revised Classification of Formations in the Arbuckle and Wichita Uplifts in Oklahoma" was prepared by Mr. Ulrich for presentation at the meeting of the Geological Society of America, and a paper entitled "Large Size of Caney Boulders" was presented at the meeting of the Paleontological Society of America. Deep-well drillings (Ordovician) were reported on by R. D. Mesler. A report on the structure of the Ouachita Mountains in Oklahoma and Arkansas was completed by H. D. Miser and transmitted to the Oklahoma Geological Survey for publication. Sales of Osage leases at Pawhuska on September 27 and December 11 were attended by P. V. Roundy, who, at the request of the Indian Service, acted as an adviser concerning bids. The new map of oil and gas fields of Oklahoma, which was revised by G. B. Richardson, has been issued on a scale of 8 miles to the inch.

Publication: Professional Paper 154-F. (See p. 3.)

OREGON

Fresh-water fossils were reported on by W. C. Mansfield, and Miocene fossil plants were studied by E. W. Berry. Upper Triassic pelecypods from eastern Oregon were identified by T. W. Stanton for James Gilluly, and Tertiary mollusks were identified by Mr. Mansfield for Bruce Clark. A preliminary reconnaissance of the geology of the eastern copper belt of Oregon was begun by Mr. Gilluly, preparatory to more detailed studies on the mineral deposits of Oregon to be undertaken in cooperation with the State Mining Board.

PENNSYLVANIA

The studies on the glacial geology of Pennsylvania carried on in cooperation with the Pennsylvania Topographic and Geologic Survey were continued by Frank Leverett, and progress was made on his reports on the glacial geology of the Susquehanna drainage basin and the glacial deposits of eastern Pennsylvania. These reports will be published by the State. A report by Mr. Leverett on the glacial geology, physiography, and drainage history of the upper Ohio Valley, embracing parts of western Pennsylvania, will be issued by the United States Geological Survey as a professional paper. M. R. Campbell continued his cooperative study of the physiographic problems in eastern Pennsylvania, making a special study of river gravel. Other cooperative projects include field and office studies of the geology and mineral resources of the Middletown, York, and Hanover quadrangles, by Anna I. Jonas and G. W. Stose, Miss Jonas working for the State survey. Mr. Stose made field investigations of the Martinsburg-Medina contact for the Pennsylvania survey and continued work on the geologic map of Pennsylvania being compiled by the State survey. Field work in the Butler and Zellenople quadrangles was practically completed by G. B. Richardson, who also made progress on his report on the geology and mineral resources of these quadrangles and completed a report on the geology, coal, oil, and gas resources of the New Kensington quadrangle. Work on the detailed report on the geology of the Tyrone quadrangle was continued by Charles Butts, who collected and studied fossils from the Bradford oil sand in McKean County and reported on collections from Crawford County. Carboniferous invertebrates were studied by G. H. Girty. E. O. Ulrich collected Ordovician fossils and carried on field studies in Perry and Lancaster Counties.

SOUTH CAROLINA

Preparation of a report on the geology of the Coastal Plain of South Carolina was resumed by C. W. Cooke. A paper on some deep wells near the Atlantic coast in Virginia and the Carolinas was prepared by W. C. Mansfield for publication in the Proceedings of the Geological Society of Washington. Miocene invertebrate fossils were collected and studied by Mr. Mansfield in connection with his general studies of the Miocene of the Atlantic Coastal Plain.

TENNESSEE

The stratigraphy of the zinc deposits at and near Mascot was studied by E. O. Ulrich and Charles Butts, and other stratigraphic examinations were made in cooperation with the Tennessee Geological Survey. Mr. Ulrich made a preliminary study of fossils from the Ottosee formation in Grainger County.

TEXAS

W. B. Lang continued to collect samples from wells being drilled for oil in the salt basin of western Texas and southeastern New Mexico. Four Government tests in Crane, Glasscock, Reagan, and Winkler Counties were completed during the year, and a press notice giving the important potash findings in the ninth and tenth tests, in Reagan and Glasscock Counties, completed during the year, and the eighth test, in Crockett County, completed the previous year, was prepared by G. R. Mansfield and published under the title "Potash Struck by Three More Government Tests in Texas." During the three years of Government exploration for potash, under the act approved June 25, 1926, 9 Government tests have been completed in Texas and 3 in New Mexico, and reports were made by the Geological Survey on 10 of these tests. A paper on Government potash exploration in Texas and New Mexico, prepared by Messrs. Mansfield and Lang, was presented at the meeting of the American Institute of Mining and Metallurgical Engineers in New York in February and published by the Institute as Technical Publication 212. At the same meeting a paper on the mineralogy of the potash field of New Mexico and Texas was presented by W. T. Schaller. Examinations of the Cliffside dome, in Potter County, were made by E. M. Spleker at the request of the Bureau of Mines, and a confidential report with detailed subsurface and surface maps was prepared and transmitted to that bureau. Data for the revised geologic map of Texas, being compiled as a cooperative project with the Texas Bureau of Economic Geology, were obtained by N. H. Darton during field work in central and western Texas, and examinations in the Marathon Basin were made by Philip King for the same purpose. In the office Mr. Darton prepared these data for inclusion in the map. Permission was granted to Mr. Darton to publish in the Bulletin of the Geological Society of America a brief notice on the discovery of Devonian rocks north of El Paso. Supplemental field work on the Woodbine, Eagle Ford, and related formations was done by L. W. Stephenson in connection with his studies of the Upper Cretaceous formations of Texas, and he continued preparation of his report on these formations and of his cooperative monograph on the fossils of the Navarro formation of Texas to be published by the Texas Bureau of Economic Geology. Mr. Stephenson also prepared a paper on unconformities in the Upper Cretaceous series of Texas for the meeting of the American Association of Petroleum Geologists in Fort Worth, and a paper on a new *Ostrea* and a new *Ezogyrus* from the Austin chalk, for publication in the Proceedings of the United States National Museum. Several months was spent in field work in Atascosa, Frio, La Salle, Zavalla, and Dimmit Counties by Miss Julia Gardner in connection with the revision of Alexander Deussen's report on the ground waters of the Coastal Plain of Texas between the Brazos River and the Rio Grande, in cooperation with S. S. Nye, of the water-resources branch. Miss Gardner traced the nonvolcanic clays of Live Oak and McMullen Counties to correlate them with the clays in the area to the south covered by A. C. Trowbridge's report on the Tertiary and Quaternary geology of the lower Rio Grande region. The results of her investigations will be incorporated in Mr. Trowbridge's report, which will be issued as a bulletin. Miss Gardner continued field and office studies of the stratigraphy and paleontology of the Eocene and later Tertiary formations of Texas, to assist in the revision of the geologic map of the State, and completed her field studies of the Midway formation of Texas, a cooperative project with the Texas Bureau of Economic Geology. Her monograph on the fauna of the Midway formation is practically completed and will be transmitted to the State for publication. A reconnaissance study of Mesozoic stratigraphy and paleontology in western Texas was continued by T. W. Stanton, and a brief informal paper on the Del Rio and Buda formations in western Texas was given by him at the meeting of the Society of Economic Paleontologists and Mineralogists in Fort Worth. Progress on the report on the salt-dome cap rock was made by M. I. Goldman. Carboniferous invertebrates were studied in field and office by G. H. Girty, Eocene fossils by C. W. Cooke, and fossil plants by E. W. Berry. Devonian invertebrates were reported on by Edwin Kirk for Mr. Darton, and Comanche invertebrates were studied by Mr. Stanton. Cretaceous well cuttings and Carboniferous micro-fossils were examined by P. V. Roundy. Cretaceous fossils were collected and studied by J. B. Reeside, jr. Well cores in northeastern Texas were examined for fossils by W. P. Popenoe.

Publication: Professional Paper 154-F. (See p. 3.)

UTAH

A report on the geology and ore deposits of the Gold Hill quadrangle, by T. B. Nolan, and one on the geology and ore deposits of the Stockton and Fairfield quadrangles, by James Gilluly, have been completed. A section on the general geology of the Cottonwood-American Fork district is being prepared by F. C. Calkins for incorporation in the report on the ore deposits. A paper entitled "Possible Desert-Basin Integration in Utah" was prepared by Mr. Gilluly for publication in the *Journal of Geology*. Examinations in the Tintic district were made by D. F. Hewett in connection with his study of dolomitization. Field studies of the stratigraphy and structure in southern San Juan County were continued by A. A. Baker and party, and a map of the Monument Valley region was prepared by Mr. Baker. In connection with this work J. B. Reeside, jr., and Mr. Baker made stratigraphic studies of late Paleozoic and early Mesozoic rocks in southeastern Utah. A paper on correlation of the Permian of southern Utah, northern Arizona, northwestern New Mexico, and southwestern Colorado was prepared by Messrs. Baker and Reeside for publication in the *Bulletin of the American Association of Petroleum Geologists*. Detailed investigations of the stratigraphy and structure of southeastern Utah between the Colorado and Dolores Rivers in Grand County was begun by C. H. Dane and party. Quarries and drifts made by oil-shale companies near Watson and Ute Switch were examined by David White, who collected specimens in connection with his research investigation of oil shales. Proposed dam sites in the Fort Douglas Indian Reservation were examined by Messrs. Hewett and Loughlin at the request of the War Department, and reports were submitted to the Quartermaster General. A semidetalled reconnaissance of the western part of the Wasatch Plateau, including a study of the stratigraphy, structure, and coals, was begun by E. M. Spleker, assisted by A. J. Eardley, primarily for purposes of land classification. A report on bituminous sandstone near Vernal was completed by Mr. Spleker for publication in *Contributions to Economic Geology*, and progress was made on his paper on the Wasatch coal field. Studies of the Wasatch, Green River, and Bridger formations in the vicinity of Burch Fork were continued by W. H. Bradley in connection with his studies of oil shale in the Green River Basin, and a paper on the origin and microfossils of the oil shale of the Green River formation of Colorado and Utah was completed by Mr. Bradley. A paper on the varves and climate of the Green River epoch, by Mr. Bradley, will be published as *Professional Paper 158-E*. An alunite deposit near Marysville was examined by G. F. Loughlin, and a report was prepared and transmitted to the conservation branch. Progress was made on the general report on the stratigraphy of the Book Cliffs, by D. J. Fisher. Carboniferous invertebrates were identified by G. H. Girty, Upper Cretaceous invertebrates by T. W. Stanton, and Eocene land and fresh-water fossils by W. C. Mansfield.

Publications: *Professional Paper 154-G, 154-J; Bulletin 806-C*. (See p. 3.)

VERMONT

Field investigations in the Taconic quadrangle, which includes the Bennington quadrangle and small parts of the Hoosick and Greylock quadrangles in Vermont, and the preparation of a report on the area, were continued by L. M. Prindle. In connection with these studies Mr. Prindle, accompanied by G. R. Mansfield, visited several localities in the Cambridge quadrangle.

VIRGINIA

In cooperation with the Virginia Geological Survey areal and stratigraphic surveys in the southern Appalachian Valley were continued by Charles Butts and in the Piedmont region by G. W. Stose and Anna I. Jonas, in connection with the preparation of the new geologic map of Virginia, which was issued during the year by the State. Outcrops in the southwestern part of the Appalachian Valley were investigated by Mr. Butts, in company with E. O. Ulrich, to determine ages. A brief review of the work of C. B. L. Odor, of the Virginia Geological Survey, at the south end of Massanutten Mountain, was made by Mr. Butts, who studied Paleozoic invertebrates from Massanutten Mountain for Mr. Odor. Studies of the warm springs in the Shenandoah Valley and in the mountain valleys in Alleghany, Bath, and Highland Counties, in cooperation with the Virginia Geological Survey, were concluded by Frank

Reeves, who completed his report on the investigations and transmitted it to the State Survey for publication. Paleozoic invertebrate fossils from the Warm Springs area were reported on by Mr. Ulrich. Late Tertiary and Quaternary deposits were examined by W. C. Mansfield, who prepared papers on the revision of the Chesapeake group of Virginia and the Chesapeake Miocene basin of sedimentation as expressed in the new geologic map of Virginia for presentation at the annual meeting of the Geological Society of America, and a paper on some deep wells near the Atlantic coast in Virginia and the Carolinas for the Geological Society of Washington. A landslide near Arlington was examined by C. P. Ross. Geologic conditions at the District of Columbia Reformatory at Lorton, Va., were examined by T. B. Nolan. A belt of kyanite in the region around Farmville was investigated by Miss Jonas for the State Geological Survey, which has in preparation a report on the kyanite of Virginia. Office studies of the iron industry of Virginia were carried on by E. F. Burchard, and a brief statement concerning iron ore along the lines of the Chesapeake & Ohio Railway in western Virginia was transmitted to the Virginia Geological Survey for publication by the railroad company. Permission was given to E. P. Henderson to publish an article on gearksutite from Virginia in the *American Mineralogist*.

WASHINGTON

A reconnaissance study of the glacial geology and physiography of eastern Washington, including parts of Spokane, Lincoln, Adams, Columbia, Douglas, Franklin, Grant, Stevens, and Whitman Counties, was made by W. C. Alden, and the results will be incorporated in a report on the glacial geology and physiography of western Montana, eastern Washington, and northern Idaho. Deposits of diatomaceous earth in Kittitas, Yakima, and Grant Counties were examined by J. T. Pardee. Fossil plants from the Grand Conlee were studied by E. W. Berry.

Publications: Professional Paper 154-H, Bulletin 805-A. (See p. 3.)

WEST VIRGINIA

A report on the glacial geology, physiography, and drainage history of the upper Ohio Valley, embracing parts of West Virginia, is in preparation by Frank Leverett for publication as a professional paper. A paper on the need for research touching the natural resources of West Virginia was delivered by David White at the inauguration of the new president of the University of West Virginia.

WISCONSIN

Pre-Cambrian faunas were studied by E. O. Ulrich.

WYOMING

Examinations of the Green River, Wasatch, and Bridger formations in the Green River Basin, southwestern Wyoming, in connection with studies of oil shale, were continued by W. H. Bradley, who prepared a geologic map and compiled other data relative to a report on this work. An examination of the geology of the Alcova and Seminoe dam sites, in central Wyoming, was made by Mr. Bradley for the Bureau of Reclamation. A paper on the Rawlins, Shirley, and Seminoe iron-ore deposits of Carbon County was completed by T. S. Lovering for publication as Bulletin 811-D, and a memorandum for the press giving advance information on these deposits was prepared. Upper Cretaceous invertebrates from Rock River were reported on by T. W. Stanton and from the Aspen shale near Kemmerer by J. B. Reeside, jr., and Mr. Stanton. E. W. Berry revised his papers on the flora of the Frontier formation and the flora of the so-called Bridger of the Wind River Basin. Preparation of a general report on the Black Hills rim was continued by W. W. Rubey, whose report on lithologic studies of fine-grained Upper Cretaceous sedimentary rocks of the Black Hills region was approved for publication in *Shorter Contributions to General Geology*. A reconnaissance of the physiography and glacial geology of Gros Ventre Valley and Jackson Hole was made by W. C. Alden, who continued preparation of his report on the glacial geology and physiography of Wyoming.

Publications: Professional Papers 154-G, 154-J, 158-A; Bulletins 804, 806-A, 806-D. (See p. 3.)

APPALACHIAN TROUGH

In continuation of his study of the Devonian and lower Mississippian floras of the Appalachian trough, David White examined collections from Pennsylvania, West Virginia, Virginia, Tennessee, Kentucky, and Ohio.

MISSISSIPPI VALLEY

A preliminary study of physiographic features of the Mississippi Valley, from Wisconsin to the Gulf of Mexico, and of the lower valleys of the Missouri, Illinois, Ohio, Tennessee, St. Francis, White, Arkansas, and Red Rivers was made by F. E. Matthes for the purpose of planning a systematic investigation of the regimen, deposits, and geologic history of these rivers.

CANAL ZONE

A preliminary geologic study of the Madden Dam project, Alhajuela, Canal Zone, was made by James Gilluly at the request of the Governor of the Panama Canal, and a report was prepared and transmitted through the Washington office of the canal. Further examinations being recommended by Mr. Gilluly and desired by the Panama Canal officials, Frank Reeves and C. P. Ross were assigned to the task. The results of their examinations were given to the Panama Canal officials, and a report on the geology of the region has been submitted for publication as a bulletin.

PORTO RICO

The El Guineo and Matrullas dam sites were examined by T. B. Nolan at the request of the Governor of Porto Rico, and a report on these sites was transmitted through the Bureau of Insular Affairs.

GENERAL INVESTIGATIONS

Work covering broad fields of geologic research or areas not confined to individual States is in progress by many of the geologists and paleontologists. The following papers giving the results of some of these studies were submitted for publication as professional papers of the United States Geological Survey or through unofficial channels.

Lower Triassic ammonoids of North America, by J. P. Smith. Professional paper.

The flora of the Frontier formation, by E. W. Berry. Professional Paper 158-H.

Gold reserves of the United States, by G. F. Loughlin and others, prepared for the Fifteenth International Geological Congress, held in South Africa, summer of 1929. An abstract of this paper was presented to the section of mining geology, American Institute of Mining and Metallurgical Engineers.

Cycles in metal production, by D. F. Hewett. Published as part of program of committee on production control, American Institute of Mining and Metallurgical Engineers.

Review of manganese reserves, by D. F. Hewett. For subcommittee on manganese of the American Institute of Mining and Metallurgical Engineers.

Determination of anisotropism in metallic minerals, by Edward Sampson. Economic Geology.

Fluorspar in the Western States, by E. F. Burchard. Prepared for a joint committee on international control of minerals of the American Institute of Mining and Metallurgical Engineers.

Alabandite in the Southwestern States, by D. F. Hewett. Economic Geology. The properties and associated minerals of gillespite, by W. T. Schaller. American Mineralogist.

Progress in the study of clay minerals, by C. S. Ross, E. T. Wherry, and P. F. Kerr. Proceedings of the Seventh Colloidal Symposium.

Is chromite always a magnetic product? by C. S. Ross. Economic Geology.

Carbon ratios and oil gravities in the Rocky Mountain region in the United States, by C. E. Dobbin. Bulletin of the American Association of Petroleum Geologists.

Cultures of algae oolites, by W. H. Bradley. American Journal of Science.

Neue Beobachtungen über Algen als Urmaterialien der Bogheadkollen und -Schiefer, by W. H. Bradley. Centralblatt für Mineralogie, Geologie und Palaeontologie.

The fuels of the future, by M. R. Campbell. Given before the Eastern States Blast Furnace & Coke Oven Association at Pittsburgh.

Some factors for consideration in an appraisal of the oil possibilities of the United States, by David White. Presented at the Second International Conference on Bituminous Coal, at Pittsburgh.

The Atlantic and Gulf Coastal Plain, by L. W. Stephenson, C. W. Cooke, and Julia Gardner. For volume on North America in Geologie der Erde.

The glacial epoch in North America, by Frank Leverett. For volume on North America in Geologie der Erde.

Pleistocene glaciation of the Northern Hemisphere, by Frank Leverett. Presented at the meeting of Section E, American Association for the Advancement of Science, in New York; published in the bulletin of the association.

Mitrospira, a new Ordovician gastropod genus, by Edwin Kirk. Proceedings of the United States National Museum.

The status of the genus *Mariacrinus* Hall, by Edwin Kirk. Proceedings of the United States National Museum.

The Ordovician, Silurian, and Devonian of Alaska, by Edwin Kirk. Abstract to be published in Bulletin of the Geological Society of America.

Pagecrinus, a new crinoid genus from the American Devonian, by Edwin Kirk. Proceedings of the United States National Museum.

Known species of *Telephus*, *Glaphurus*, and *Glaphurina* and ages of beds containing them, by E. O. Ulrich. Proceedings of the United States National Museum.

Criteria in distinguishing fossil faunas of the Arctic region from those developed in other seas, by E. O. Ulrich. Presented at the annual meeting of the Paleontological Society of America.

Triassic and Jurassic of the Arctic region, by T. W. Stanton. Abstract in Bulletin of the Geological Society of America.

Cretaceous of the Arctic and subarctic regions, by J. B. Reeside, jr. Abstract in Bulletin of the Geological Society of America.

New Carboniferous invertebrates (I), by G. H. Girty. Journal of the Washington Academy of Sciences.

Late geological deformation of the Appalachian Piedmont as determined by river gravels, by M. R. Campbell. Proceedings of the National Academy of Science.

The geomorphic value of river gravel, by M. R. Campbell. Bulletin of the Geological Society of America.

The river system: a study in the use of technical geographic terms, by M. R. Campbell. Journal of Geography.

Rainfalls accompanying explosive eruptions of volcanoes, by R. H. Finch.

Memorial to Joseph Silas Diller, by A. J. Collier. Bulletin of the Geological Society of America.

Thomas Chrowder Chamberlin's contributions to glacial geology, by W. C. Alden. Journal of Geology.

Incompleted projects on which work was accomplished comprise a report on the copper deposits of the southern Appalachian region, by C. S. Ross and M. N. Short; a report on the geology of the Great Basin, by D. F. Hewett; studies of Appalachian oil fields by G. B. Richardson; a report on antimony deposits of the world, by F. C. Schrader; investigations of salt-dome cap rock, by M. I. Goldman; studies of the stratigraphy and paleontology of the Appalachian Valley and of the Upper Cambrian trilobites, by E. O. Ulrich; a report on early Paleozoic cephalopods, by Mr. Ulrich and A. F. Foerste; investigations of the Cretaceous formations of the Western Interior province, by J. B. Reeside, jr., including papers on pelecypods of the Eagle sandstone and related formations, ammonites of

the Greenhorn limestone, new species of scaphites, and a chapter on the geology of the Rocky Mountains and northern plateau region for *Geologie der Erde*; studies of Devonian-Carboniferous faunas, by G. H. Girty; studies of Paleozoic ostracode genera and a paper on some species of *Paraparchites*, by P. V. Roundy; studies of the Eocene Foraminifera of the Atlantic Coastal Plain, by J. A. Cushman; research on microchemical methods of ore identification and on certain nickel ores, by M. N. Short; studies on the selenium content of zinc sulphides, by C. E. Siebenthal and R. C. Wells, and on granite for acid towers, by G. F. Loughlin; investigations in connection with the tectonics committee of the National Research Council, by G. R. Mansfield; and earthquake studies, by Arthur Keith.

WORK IN CHEMISTRY

The work in chemistry was carried on by eight chemists. One chemist, R. K. Bailey, was transferred in August to Roswell, N. Mex., where he collects potash cores and samples and makes qualitative tests.

During the year 8,910 specimens were analyzed.

The study and experimental work on ore deposition was continued with gratifying results by R. C. Wells. This research included dolomitization, the origin and replacement of minerals, and similar phenomena. Mr. Wells also started an investigation including laboratory experiments on the diffusion of gases through rocks and other slightly permeable materials with a view to explaining the separation and movement of gases through rock formations and their concentration in specific localities. He also made a study and tests of methods for determining small quantities of selenium and for the separation of rare-earth metals.

Short researches on a hydrous phosphate from Virginia, phillipsite in manganese ore from Nevada, spadaite from Utah, hydrozincite from Nevada, ammonium borate from Italy, and the properties of minerals associated with gillespite were made by W. T. Schaller. Besides preparing the manuscripts credited to him in the list of papers given below, Mr. Schaller read the following papers before scientific societies:

Crystallography of quartz pseudomorphs after glauberite.

Ludwigite group.

Ending of chemical adjectives in describing isomorphous minerals.

Halite-anhydrite intergrowths.

Serendibite from New York.

Mineralogy of the cores from the New Mexico-Texas potash field.

Additional laboratory work was done on the chemical disintegration of Indiana limestone and the composition of its insoluble residue by George Steiger. Mr. Steiger also made a study with laboratory experiments on the permeability of granite and prepared for the committee on sedimentation of the National Research Council a bibliography of chemical works published during the year having a bearing on the problem of sedimentation.

Exhaustive experiments in perfecting a method for determining small quantities of selenium were made by E. T. Erickson. It is now possible to identify definitely as small a quantity of this metal as 1 part in 500,000.

A series of dehydration tests on certain clays in a study on the rôle of water in the clay minerals were made by J. G. Fairchild in cooperation with C. S. Ross.

In the search for potash 11 cores from wells drilled especially in the interest of this project were received in the Washington laboratory and studied in detail. In addition 5,880 samples of cuttings, which were taken from 56 different wells being drilled for oil, were assayed or otherwise tested for their potash content. Three of the cores came from wells drilled in Crockett, Reagan, and Glasscock Counties, Tex., under the auspices of the Bureau of Mines, with funds appropriated by Congress for the investigation of potash deposits. Numerous beds of salts were encountered that were sufficiently high in their potash content but rather thin to be of economic interest. Excellent showings were made by seven cores taken from wells drilled by private interests in a field in Eddy County, N. Mex. Seventeen wells have been drilled in developing this field, each of which gave good showings for potash-rich salts, but two of those drilled this year deserve special mention. Both wells are in the western part of the field, about a mile apart. The first well pierced seven beds, each over 2 feet in thickness, composed of salts showing a potash content of more than 10 per cent. The second well pierced four beds thicker than 2 feet each, composed of salts containing more than 12 per cent of potash.

The following papers were completed during the year:

Steiger, George, Indiana oolitic limestone [part of U. S. Geol. Survey Bull. 811-C].

— Investigations of chemistry that have a bearing on problems of sedimentation [to appear in annual report of committee on sedimentation, National Research Council].

Schaller, W. T., Borate minerals from the Kramer district. Calif.: U. S. Geol. Survey Prof. Paper 158-I (in press).

— The properties and associated minerals of gillespite [to appear in *Am. Mineralogist*].

Erickson, E. T., The determination of small quantities of selenium in ores [to appear in *Washington Acad. Sci. Jour.*].

Fairchild, J. G., Base exchange in artificial autunites [to appear in *Am. Mineralogist*].

Henderson, E. P., Gearksutite from Hot Springs, Va. [to appear in *Am. Mineralogist*].

WORK IN PHYSICS

Field observations of deep earth temperatures were made by C. E. Van Orstrand from March 26 to September 12, 1928, and in June, 1929, in Alabama, Kansas, Texas, Oklahoma, California, Montana, and Wyoming. Some of the observations were made in cooperation with the American Petroleum Institute. Apart from administrative duties, Mr. Van Orstrand devoted his time in the office to the preparation of scientific papers and the review of observations of deep earth temperatures submitted by three research associates of the American Petroleum Institute, working in Texas, Oklahoma, and California.

The investigation of the association of water and petroleum with silica and various silicates and with alumina and hydrous ferric oxide was continued by P. G. Nutting, who has applied his results in studies of filtering earths, oil sands, and the formation of asphalt

beds. The theory of cohesive pressures in adsorbed films has been further developed and applied. Methods of determining the permeability of oil sands and other rocks have been studied and the results applied to field problems, such as dam seepage and petroleum recovery. Among the papers published that on deformation and temperature gives new formulas for calculating the heat developed by compression in rocks.

The following papers were completed during the year:

- Nutting, P. G.,** Some geological consequences of the selective adsorption of water and hydrocarbons by silica and silicates: *Econ. Geology*, vol. 23, pp. 773-777, 1928.
- Deformation and temperature: *Washington Acad. Sci. Jour.*, vol. 19, pp. 109-115, 1929.
- Petroleum and the filtering earths: *Washington Acad. Sci. Jour.*, vol. 18, pp. 409-414, 1928.
- Petroleum recovery by the soda process—III: *Oil and Gas Jour.*, Oct. 18, 1928, p. 146.
- Internal pressures in adsorbed films [to appear in *Washington Acad. Sci. Jour.*].
- Van Orstrand, C. E.,** Geothermal surveys in the United States: *United States Daily*, Feb. 15, 1929.
- On the detection of inhomogeneities in the crust of the earth by means of deviations in the isogeothermal surfaces [to be published by the National Research Council].

ALASKAN BRANCH

PHILIP S. SMITH, Chief Alaskan Geologist

ORGANIZATION AND PERSONNEL

The organization of the Alaskan branch remains unchanged at the end of the year. The force comprises the chief Alaskan geologist, 3 geologists, 1 supervising mining engineer, 2 topographic engineers, 1 coal-mining assistant, 1 draftsman, and 3 clerks.

FUNDS

The funds used by the Geological Survey in its Alaskan work are provided in two items in the general act making appropriations for the Interior Department. One of these items reads, "for continuation of the investigation of the mineral resources of Alaska * * *." In the act for the fiscal year 1929 the amount was \$64,500, which was later increased \$3,000 through the provisions of the deficiency act to take care of salary advances made under the Welch Act. In the similar act for 1930 the amount appropriated was \$67,500. Each of these appropriations was made available immediately on the passage of the act in which it was contained. The other item is an allotment made from the appropriation "for the enforcement of the provisions of the acts of October 20, 1914, October 2, 1917, February 25, 1920, and March 4, 1921, and other acts relating to the mining and recovery of minerals on Indian and public lands and naval petroleum reserves * * *." Allotments under this item are available only during the fiscal year specified. In the fiscal year 1928 an allotment of \$14,500 was made for work of this kind in Alaska; in 1929,

\$10,000. The two types of work indicated will be described for convenience as the work on mineral resources and the leasing work.

WORK ON MINERAL RESOURCES

PRINCIPAL RESULTS OF THE YEAR

The principal products of the work of the Geological Survey in Alaska are reports and maps based on original surveys or investigations. During the year eight reports have been issued, as follows:

- The Skwentna region, by S. R. Capps (Bulletin 797-B).
- Preliminary report on the Sheenjek River district, by J. B. Mertie, jr. (Bulletin 797-C).
- Surveys in northwestern Alaska in 1926, by Philip S. Smith (Bulletin 797-D).
- Aerial photographic surveys in southeastern Alaska, by R. H. Sargent and F. H. Moffit (Bulletin 797-E).
- Geology and mineral resources of the Aniakchak district, by R. S. Knappen (Bulletin 797-F).
- Mineral industry of Alaska in 1927, by Philip S. Smith (Bulletin 810-A).
- Administrative report, 1927-28, by Philip S. Smith (Bulletin 810-A).
- Geology of Hyder and vicinity, southeastern Alaska, with a reconnaissance of Chickamin River, by A. F. Buddington (Bulletin 807).

Five reports have been completed by their authors and approved for editing or printing, as follows:

- Notes on the upper Nizina River, by F. H. Moffit (Bulletin 810-D).
- Administrative report, 1928-29, by Philip S. Smith (Bulletin 813-A).
- The Chakachatna-Stony region, by S. R. Capps (Bulletin 813-B).
- Mining in the Fortymile district, by J. B. Mertie, jr. (Bulletin 813-C).
- A geologic reconnaissance of the Fortymile-Tanana district, by J. B. Mertie, jr.

The following reports are in press:

- The Upper Cretaceous floras of Alaska, by Arthur Hollick, with a description of the Upper Cretaceous plant-bearing beds by G. C. Martin (Professional Paper 159).
- Geology and mineral deposits of southeastern Alaska, by A. F. Buddington and Theodore Chapin (Bulletin 800).
- The Chandalar-Sheenjek region, by J. B. Mertie, jr. (Bulletin 810-B).
- The Mount Spurr region, by S. R. Capps (Bulletin 810-C).
- Geography and geology of northwestern Alaska, by Philip S. Smith and J. B. Mertie, jr. (Bulletin 815).
- Geology of the Eagle-Circle district, by J. B. Mertie, jr. (Bulletin 816).

Six other reports are in preparation but have not approached near enough to completion to warrant any definite statement as to the time of publication.

Practically all the completed reports are accompanied by maps, the base of which has been made principally from surveys conducted by the topographers of the Alaskan branch. The following maps have been published:

- Drainage map of part of the Hyder-Ketchikan region, southeastern Alaska, compiled under direction of R. H. Sargent; mainly from aerial photographs made by the Navy Department at the request of the Geological Survey; scale, 1:250,000. Published in Bulletin 797-E.
- Topographic map of the Hyder district (new ed.), by R. M. Wilson; scale, 1:62,500. Published in Bulletin 807.
- Topographic map of the Pavlof region, Alaska Peninsula; scale, 1:250,000; by C. P. McKinley, for the National Geographic Society's Pavlof Volcano Expedition. Issued in a free preliminary photolithographic edition.

The maps listed below were completed during the year under the direction of R. H. Sargent and submitted for publication:

Topographic map of Valdez and vicinity, by J. W. Bagley and C. E. Giffin; scale, 1:62,500. To be published as a sale map. The base of this map is largely the Port Valdez map, now out of print, but it covers a somewhat larger area, has been revised and brought up to date, and includes the results of hitherto unpublished surveys.

Topographic map of Revillagigedo Island, southeastern Alaska, by R. H. Sargent; scale, 1:125,000. The topography of this map is from surveys made in 1928 by the usual ground methods, but the drainage features are taken from the Hyder-Ketchikan map, which was compiled from aerial photographs. To be issued as a free preliminary photolithographic edition.

Progress was also made in the compilation of a topographic map of the Mount Spurr region, scale, 1:250,000, from recent surveys.

The base map of Alaska on a scale of 1:5,000,000 was brought up to date, and considerable work was done toward the revision of the map on a scale of 1:2,500,000.

Besides the official reports, several articles were prepared by the scientific and technical members of the Alaskan branch for publication in outside journals, and 10 or more public lectures were given regarding the general work of the branch or some of its special features. Most of these were prepared unofficially but represent excellent by-products of the regular work and serve to reach special audiences not readily reached by the regular official publications. Among these articles may be mentioned the following:

Gold reserves of Alaska, by Philip S. Smith, for presentation at the International Geological Congress in South Africa, 1929.

Geology and geography of Alaska, by Philip S. Smith, for publication in "Geology of North America," included in "Geologie der Erde" in process of compilation.

The pre-Cambrian of interior Alaska, by J. B. Mertie, jr., delivered before the Geological Society of Washington.

Notes on geographic features of Alaska, by R. H. Sargent, delivered at the meeting of the Association of American Geographers in New York.

Field work of the Geological Survey in 1928, by F. H. Moffit, for publication in Alaska newspapers.

Our northern frontier territory, by Philip S. Smith, delivered before the Service Club of the Signal Corps, U. S. A.

PROJECTS IN PROGRESS DURING THE SEASON OF 1928

Some of the results that the Geological Survey has accomplished in its Alaska work may be expressed in terms of the area covered. The areas reported in the following table are based on the field season and not on the fiscal year, and therefore no account is taken of the work that was started during the field season of 1929 but remained uncompleted at the end of the fiscal year. This procedure has been adopted in part because most of the parties at work during the field season of 1929 are out of communication and so can not yet report the extent of the work they have accomplished, but in part it has been adopted because the field season is a more practicable unit of measurement.

Areas surveyed by Geological Survey in Alaska, 1898-1928, in square miles

Field season	Geologic surveys			Topographic surveys		
	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)
1898-1927.....	75, 150	169, 305	4, 277	55, 630	204, 565	4, 001
1928.....		5, 450			* 3, 965	
Percentage surveyed of total area of Alaska.....	75, 150	* 174, 305	4, 277	55, 630	208, 530	4, 001
	43.3			45.8		

* Includes 2,000 square miles mapped by National Geographic Society Pavlov Expedition on Geological Survey standards.

* 450 square miles surveyed prior to 1928 deducted because of resurvey during 1928.

In this table only the net areas surveyed are listed in the appropriate column, though of course most of the areas that have been surveyed geologically have also been surveyed topographically. It is by no means unusual that areas surveyed hastily are resurveyed later with more precision. If the areas thus revised were not excluded from the totals the same area would be counted twice. It is for this reason that an area of 450 square miles which was reexamined geologically in 1928 has been deducted from the total in the column of reconnaissance geologic surveys. The necessity for resurveying some areas in more detail is generally due to the need of covering a large tract rapidly at first. As development takes place in certain parts of that large tract more accurate and detailed work may be required to furnish the desirable information. This policy is well illustrated by the procedure adopted in surveying the Seward Peninsula placer camps. Within two or three months after the return of the Federal geologist from this field during the height of the first stampede to Nome a rough exploratory map and a report on the environs of Nome were published by the Geological Survey. During the next field season reconnaissance surveys of the entire region within 100 miles of Nome were made, and later these were succeeded by detailed mapping and reports of the smaller tracts in the vicinity of the richest camps.

The scale most commonly adopted for Alaska surveys is 1:250,000, in which 4 miles on the ground is represented by an inch on the map, with a contour interval of 200 feet. This scale is adequate for most general purposes, and the surveys can be made expeditiously and cheaply. It is obvious, however, that such a scale can not effectively show detailed features of topography or geology, and yet many of these are of prime importance in their relations to the mineral resources of the region. Therefore, although more than two-fifths of the Territory has been mapped on reconnaissance or exploratory standards, there is constant demand for more detailed work, and this demand will become more and more insistent as the Territory develops. Even for the reconnaissance type of mapping there still remains about 200,000 square miles of unsurveyed territory that holds promise of containing mineral deposits of value. At the present rate it will be many decades before even the reconnaissance mapping of the prospective mineral areas can be completed, and the

equisite detailed mapping of the most promising tracts must be postponed far into the future or must supplant the equally pressing reconnaissance work unless more funds are made available.

The surveys in 1928 tabulated above were made in the Ketchikan and Juneau districts of southeastern Alaska, the Chitina-Nizina district of the Copper River region, the vicinity of Mount Spurr in the Alaska Range, and a tract lying north of the Tanana River and west of the international boundary. The work in the Ketchikan district was reconnaissance topographic mapping conducted by L. H. Sargent. Ores of various metals have long been known to occur here, and some of them have been worked more or less successfully. Owing to the easy accessibility of most parts of the district to ocean transportation, many of the costs of development will probably be low, and the general geologic conditions are such as to encourage search for deposits of commercial extent. Although the principal object of this mapping was to furnish a topographic base that would serve for the mineral investigations, it has met an immediate need of those concerned with the development of the timber, pulp, and water-power resources of this district. This project is of special technical interest because the topographer made use of the first of the drainage maps compiled from the aerial photographs taken for the Geological Survey by the Navy Department in 1926. The use of these aerial pictures proved highly advantageous in facilitating the work of the topographer in this region of high relief and almost impenetrable timber cover. As the photographs taken by the naval expedition cover nearly 10,000 square miles of southeastern Alaska, this project is the forerunner of similar surveys that will be carried on in this region as rapidly as funds and personnel permit.

The surveys in the Juneau region were made by R. K. Lynt, a topographer of the Geological Survey, who was temporarily assigned to duty with a party of the Forest Service. This work was especially desired by the Forest Service in connection with its activities in developing the paper-pulp industry in southeastern Alaska, and although the Geological Survey would doubtless have mapped that area in the course of its regular mineral investigations, the immediate needs of the Forest Service were so urgent that that organization bore the entire cost, and the resulting map was turned over to it. The work has not been included in the table of areas surveyed, nor in the table of expenditures. It covered a small tract on the west coast of Admiralty Island and was done with the accuracy required for publication on a scale of 1:62,500. The tract is exceedingly difficult to survey, and the map covered an area of only a few square miles.

The work in the Nizina district of the Copper River region consisted principally of the revision of earlier geologic surveys and the critical study of some of the places where different interpretations that have been advanced could be tested. This work was done by F. H. Moffit, who with a small pack train and camp assistant traversed much of the known copper-bearing region north of the Chitina River and greatly refined the broad determinations of the geology resulting from earlier more hurried expeditions. The more precise knowledge of the stratigraphy and geologic history thus obtained is essential in directing the search for valuable deposits in this important mineralized region. Mr. Moffit also spent some time at the large copper mines near Kennecott and at the placer gold camps on Dan and Chittitu Creeks and visited most of the places in the district where prospecting has recently been in progress.

In the vicinity of Mount Spurr, in the Alaska Range west of Anchorage, a combined geologic and topographic party in charge of S. R. Capps, geologist, with Gerald FitzGerald as topographer, carried on extensive surveys by means of a pack-train expedition. The geologist, topographer, and recorder were carried by airplane to the point where the surveys were to be started, and the trip from Anchorage consumed one hour and twenty minutes, whereas the pack train that was sent overland from the west shore of Cook Inlet took over 20 days to make the trip. It is evident that in a region like the Alaska Range, where the working season is limited to less than 100 days, this great saving in time is of paramount importance. Moreover, the saving in food and salaries almost, if not quite, makes this means of transportation cheaper than tramping on foot across the country. The geologic and geographic results of this work are of great interest and significance. The party traversed with pack train a pass across the Alaska Range leading on the west side to streams flowing into the Stony River, one of the large southern tributaries of the Kuskokwim River,

and mapped a tract of 1,000 square miles that has hitherto remained on all authoritative maps of the Territory.

A triangular area in the vicinity of the international boundary the Tanana River and extending more than 100 miles to the west, the gold placer camps of the Fortymile district, had been covered by a reconnaissance topographic map some years ago, but until the season of 1911 it was not been possible to map the area geologically. In that season J. L. G. Jr., with a small pack train and two camp assistants, left Eagle to make reconnaissance geologic surveys. A serious injury to one of the assistants before reaching the field necessitated the return of the party to get medical attention. The loss of the assistant still further hampered the party, which had been undermanned even before the accident, but in this Mr. Mertie pushed ahead with only one camp hand and was successful in mapping the major geologic features of an area of nearly 4,000 square miles. The geologic features observed seem to indicate that at a number of localities the conditions are favorable for the occurrence of gold lodes, and that a concentration has been effective placer deposits may be sought with confidence and assurance of success.

The only other field work that was done during the season of 1911 was by a member of the staff having headquarters in Washington was the completion of a broad survey of recent developments in the mining industry as well as with special visits to some of the more active mining camps or districts that had not been recently visited by members of the Geological Survey. This work was done by the chief Alaskan geologist and included visits to the districts of Ketchikan, Juneau, Kennecott, Fairbanks, Tenderfoot, Hot Springs, and others. A general familiarity with the mining industry such as is gained by a rapid survey of this type is regarded as essential in keeping abreast of recent developments and in laying out plans for future work so that it will fit the needs of the mining industry.

The Geological Survey maintains in Alaska two district offices, one at Juneau and one at Anchorage. The main duties of the personnel at these offices relate to mineral leasing, but about two-fifths of the time of B. D. Stewart, who is in direct charge of the local offices, was spent in general investigations of mineral resources, including both office and field visits to various parts of the Territory as conditions warrant. Mr. Stewart's long familiarity with mining matters throughout the Territory and his ability for consultation at Juneau have made his advice much sought by many of the Federal and Territorial agencies in Alaska, including the Alaska Railroad, the Forest Service, the governor, and members of the Territorial legislature, as well as by many of the individual operators and prospectors. The Alaska offices also act as local distributing points for publications of the Geological Survey and assist in furnishing the main office at Washington with information on many phases of the mineral industry in the Territory.

A field project that strictly does not properly belong to the work of the Alaskan branch, as it was financed by a non-Federal organization and was carried out by members of the Geological Survey who belong to other branches, was the National Geographic Society's Pavlof Expedition to the Alaska Peninsula, which was in charge of T. A. Jaggar, jr., volcanologist, with C. P. Silliman as topographer. Through the courtesy of the National Geographic Society the excellent topographic field sheets that resulted from this survey were made available without expense to the Geological Survey, which has incorporated the resulting map in a preliminary edition that is in every respect comparable to the standards used for its own maps. The area covered by this map has been included in the table on page 32. This adds one more to the long list of notable contributions which the National Geographic Society has made to Alaskan exploration.

In addition to these distinctly field projects the Alaskan branch prepares and issues statements regarding the production of mineral commodities in the Territory.

Each of the field projects involves considerable office work in examining and testing the specimens collected, preparing the illustrations and maps, and writing the reports. In all the office work on the technical reports the members of the Alaskan branch have received much assistance and valuable advice from their associates in other branches of the Geological Survey. T. W. Higginson, G. H. Girty, J. B. Reeside, jr., Edwin Kirk, David White, and E. V. Shreve, paleontologists, have examined and reported on the fossils collected in the surveys. The map editors have been especially helpful in critically examining

the Alaskan topographic maps that were in course of preparation to see that they conform so far as practicable to the best Geological Survey standards.

PROJECTS FOR THE SEASON OF 1929

The six projects that were approved for the season of 1929 had been under way for only a short time at the end of the fiscal year, and most of the parties are out of touch with ordinary means of communication, so that no specific details are available regarding the work accomplished. The principal objects of these projects are topographic studies in connection with the airplane photographing expedition of the Navy Department in the northern part of southeastern Alaska; geologic reconnaissance surveys in the Alaska Range in the vicinity of Mentasta Pass and Chistochina, at the head of the Copper River Basin; a combined geologic and topographic reconnaissance survey of an unexplored tract of the Alaska Range northwest of Lake Clark, in southwestern Alaska; a geologic reconnaissance of the White and Crazy Mountains, in the north-central part of the tract between the Yukon and Tanana Rivers, central Alaska; investigations of mineral properties in the vicinity of the Alaska Railroad; and the usual general inspectional trip.

The projected work in southeastern Alaska is essentially a part of the undertaking by the Navy Department to photograph from airplanes a large tract, including Baranof and Chichagof Islands and contiguous territory. This work is a continuation of similar work done in 1928, when about 10,000 square miles of the southern part of southeastern Alaska was photographed and the resulting films were turned over to the Geological Survey for working up into drainage maps. The value of the pictures was at once apparent, and subsequently the Forest Service, feeling the urgent need of similar pictures for the northern part of this region, entered into an agreement whereby the work should be resumed by the Navy during the season of 1929. Under this agreement most of the extra expense of the photographic work is borne by the Forest Service, the Geological Survey contributing only \$2,000 and the services of R. H. Sargent, topographer, who serves as technical adviser to see that the resulting films are suitable for cartographic use. It is expected that as a result of this work many thousand new films will be obtained and that with these, together with those already in hand from the earlier expedition, it will be practicable to compile drainage maps of almost all the hitherto unmapped portions of southeastern Alaska. The task of taking off the cartographic data from these views is laborious, and the funds for this work at the disposal of the Geological Survey are so small that unless they are materially increased these valuable data can not be worked up into maps in the near future. The former success of the Navy in this work and the whole-hearted enthusiasm with which its personnel have engaged in the new project give every assurance of its successful completion. The resulting maps will be of service not only to the Geological Survey in its mineral investigations but to everyone having an interest in the development of any of the natural resources of this region. The topography of southeastern Alaska gives a very severe test of the application of methods of photographic surveying, because the relief of the country is so strong that distortion of scale is especially great. Furthermore, the atmospheric conditions are bad, with a great amount of clouds and rain and the intricate interspersal of land and water areas. Aerial photographic methods, however, have many advantages over ground methods in this region, because of the difficulty of traversing on foot the high ridges, precipitous ledges, and almost impenetrable jungle of forest and brush-clad slopes.

The geologic reconnaissance in the Alaska Range, at the head of the Copper River, is being conducted by F. H. Moffit, accompanied by a small pack train and two camp assistants. The country adjacent to Mentasta Pass has long been known to be mineralized, affording evidence of the presence of gold and lead and some indications of the presence of copper. Development work is in progress in this district on prospects of lode gold and lead. Productive gold placers have long been worked in the Slate Creek district, which lies along the western margin of the area to be surveyed. The region as a whole lies across the axis of the Alaska Range, and the surveys are expected to yield information as to the relation of the metamorphic rocks on the north side of the range to the Paleozoic and Mesozoic sediments on the south. A part of the area was mapped both topographically and geologically by hasty reconnaissance methods in 1902, but the results of the geologic investigations were never published. It is especially desirable now to revise and extend that

mapping in the light of the present knowledge of the stratigraphy and the renewed interest that is being taken in the mineral deposits in this general region.

The combined geologic and topographic surveys to be made in the Alaska Range region north and west of Lake Clark are in charge of S. R. Capps, geologist, with Gerald FitzGerald, topographer. These surveys started from the previously surveyed region adjacent to Lake Clark and will extend northward as far as time and other conditions permit, possibly tying in with the surveys made during the field season of 1928 in the valley of the Stony River, a tributary of the Kuskokwim. The surveys should fill in some of the gap that now exists between the work that has been done in the northern and central parts of the Alaska Range and that done to the south. The region holds promise of containing deposits of valuable minerals, but it is practically unexplored, and this possibility can be stated now only as a surmise. In fact, the absence of authoritative information regarding it makes its exploration especially desirable at this time.

The work in the Yukon-Tanana region will be principally a geologic reconnaissance and revision of the older mapping of parts of the country adjacent to the White Mountains and the extension of the surveys northward to the Yukon Flats and eastward to the Crazy Mountains. The work is in charge of J. B. Mertie, jr., accompanied by a pack train and two camp assistants. The party will have the opportunity of visiting some of the old placer camps, especially those near Circle, and will collect information regarding the progress of mining and prospecting in those places. This work is part of the general revision that Mr. Mertie has been carrying on for a number of years in the Fairbanks and Circle districts. The results of this critical study, when completed, should be of much significance in determining the general geologic history of the region and in throwing light on the conditions under which the mineralization was effected and consequently giving clues to the places where further prospecting is most likely to be successful.

Early in 1929 O. F. Ohlson, in charge of the Alaska Railroad, broached the question of organizing a geologic staff as part of the railroad personnel, to assist the railroad in its search for tonnage and in solving problems that arose in its work that required this special type of information. The Geological Survey agreed to make available to the railroad the services of an engineer or geologist for about four months a year and to meet so far as possible any requests for areal work that might be submitted by the railroad officials. This arrangement was started in the season of 1929, and at the end of the fiscal year the results were not yet sufficient to afford adequate measure of its success. It is proposed that in the main the needs of the railroad for an engineer or geologist shall be taken care of by members of the staff attached to the local offices at Anchorage and Juneau. If necessary, additional assistance will be given by the chief Alaskan geologist or such other members of the field force as may be in the general neighborhood of the railroad. The successful operation of the railroad as a means of developing Alaska is of most vital concern to the entire mining industry, and the Geological Survey in its relation to that industry feels keenly concerned with making this cooperation effective.

The general work on mineral resources done by B. D. Stewart from the Alaska offices, in addition to that called for by the arrangement with the Alaska Railroad, will be similar to that of the season of 1928. It will consist in such general field studies as time and other conditions permit, the maintenance of office records, the answering of inquiries, and the holding of such conferences as may be required.

The only other field work that the Geological Survey proposes to do in Alaska in 1929 is the customary broad survey of recent developments in the mining industry as a whole, with special visits to some of the more active camps and to some of those that have not been visited recently by members of the Geological Survey. This work will be done by the chief Alaskan geologist, who will reach Alaska late in July and spend the rest of the season on the projects.

EXPENDITURES

The funds used for the work of the Geological Survey on Alaska's mineral resources during the field season of 1928 were made available through the Interior Department appropriation acts for the fiscal

years 1928 and 1929. For a large part of the time the two appropriations were running concurrently. All the expenditures have been properly accounted for under the usual system of bookkeeping, but the analysis from that standpoint gives only an imperfect picture of the real conduct of the work. In the following statement an attempt has been made to summarize the expenditures under a number of major heads, so as to show the principal objects for which the funds appropriated during the fiscal year 1929 were expended.

Expenditures from funds appropriated for investigation of mineral resources of Alaska for the fiscal year 1929

Projects for the season of 1928.....	\$13,566
Projects for the season of 1929.....	11,350
Administrative salaries.....	3,150
All other technical and professional salaries.....	28,167
All other clerical and drafting salaries.....	7,667
Office maintenance and expenses.....	3,251
Balance.....	349
	<hr/>
	67,500

In the first two items in the foregoing statement no charges are included for the salaries of any of the permanent employees of the branch, as all these are carried in the three following items. Proper proportional charges for these services, as well as for the expenditures listed as office maintenance and expenses, might well have been made in these first two items, for practically every expenditure made by the branch relates more or less directly to these projects.

The expenditures for the projects of 1928 amounted to \$13,566, which includes \$7,938 for geologic and general investigations and \$5,628 for topographic work. These figures are based on the assumption that in combined geologic and topographic parties the expenses are divided equally between the two types of work. A similar analysis shows that expenditures from funds for the fiscal year 1929 amounted to \$11,350, of which \$6,675 was for geologic work and \$4,675 for topographic work. Of the total allotted to field projects for both seasons about 58 per cent was allotted to geologic or related general work and 42 per cent to topographic work.

The item for administrative salaries in the foregoing table includes only those salaries that are directly related to general administration and does not include charges for administration such as each party chief is called on to perform with regard to the party in his charge. During the fiscal year the chief Alaskan geologist was in the field until early in October and was on leave from April 3 throughout the rest of that year. During his absence the general administration of the branch was carried on by S. R. Capps until he left in May to undertake field work in the Alaska Range region. During part of May and all of June Miss L. M. Graves served for the chief of the branch. Part of Mr. Stewart's salary has been included in this item, as the local administration of the Alaska offices is in his charge. The low cost of administration is due principally to the fact that the administrative officers are engaged also in technical projects, which therefore have their proportional charge of their salaries. This makes for low cost of administration but less

sens the amount of time available for real directive handling of many of the affairs of the branch and would not be at all practicable except with a branch whose personnel has long been familiar with the work to be done and is well qualified to solve for itself many of the problems that arise.

The item for clerical and drafting salaries for the Washington office covers part of the salary of the chief clerk, a junior clerk, and a draftsman, and the services for a little more than three months of a stenographer. In addition the item includes part of the salary of a clerk in the Anchorage office. Approximately three-fourths of the time of the junior clerk in the Washington office is devoted to the canvass and compilation of data regarding the production of minerals and work related thereto, which is practically a technical project. The draftsman is engaged in all kinds of map preparation, especially in the finer kinds of work required where photolithographic methods are to be used for reproducing the original copy. The present clerical and drafting personnel is entirely too small to handle the volume of business that passes through the office. Curtailments in appropriations have been met by curtailments in the clerical force, so as to make as much money as possible available for the field projects. This procedure is having an injurious effect on the work as a whole and should not much longer be continued.

The item for office maintenance and expenses includes all the miscellaneous expenses incident to the general conduct of the work that are not directly part of a definite project. By far the heaviest charges entering into this item during the fiscal year were those for new instruments, amounting to \$1,742 and including a transit and equipment, a telescopic alidade to replace instruments that have been long in service and are now worn out, a photographic printer especially designed for airplane films, and a special stereoscopic apparatus necessary for handling the airplane views when being used for map compilation. The amount thus spent represents in fact a replacement that will not be necessary again for some years, unless the scope of the work is expanded. The next largest item of expense under this heading covers photographic and related work, which amounted to about \$800. Nearly 40 per cent of this total represents the cost of preparing a preliminary edition of the Pavlof map which was made available to the Geological Survey by the National Geographic Society, and 15 per cent was for work on the drainage map prepared from airplane pictures of part of southeastern Alaska. The cost of all the other supplies and equipment for the branch was considerably less than 1 per cent of the total appropriation. This amount is rather less than can be consistently maintained.

In the following tables the cost of the salaries charged against each project is only approximately accurate, for the whole time of a geologist or topographer assigned to a project is charged against that project, whereas much of his time at the office is required for miscellaneous duties. The columns of salaries, except as specifically noted, do not include administrative or clerical salaries, and the columns of expenses do not include items charged to office maintenance or expense. For these reasons, as well as because two different appropriation years are tabulated together, the total given in the last column does not equal, even approximately, the total given in the table on page 37 for a single fiscal year.

Approximate cost and distribution of work by geographic divisions for the season of 1928

Region or work	Appropriation for 1928		Appropriation for 1929		Total
	Expenses	Salaries	Expenses	Salaries	
Southeastern Alaska	\$1,900	\$765	\$3,278	\$3,333	\$9,276
Copper River region	660	765	2,408	4,167	8,000
Alaska Range	2,600	1,445	4,700	7,200	15,945
Yukon-Tanana region	2,400	700	2,089	4,000	9,189
General investigations			986		4,519
Statistical studies				\$ 2,200	2,200
Alaska offices			105	\$ 2,563	2,668
	7,560	3,675	13,566	26,996	51,797

* Does not include \$1,925 transferred to Geological Survey from Forest Service for detailed topographic mapping.

† Includes \$1,515 clerical salaries.

‡ Includes \$1,000 for administrative salary and \$480 for clerical salary.

Approximate cost and distribution of work by geographic divisions for the season of 1929

Region or work	Appropriation for 1929		Appropriation for 1930		Total
	Expenses	Salaries	Expenses	Salaries	
Southeastern Alaska	\$ 2,350	\$833	\$600	\$4,167	\$7,980
Copper River region	1,800	833	3,000	4,167	9,800
Alaska Range	4,650	1,533	3,585	7,670	17,438
Yukon-Tanana region	2,550	800	3,150	4,000	11,500
General investigations			1,000	2,400	3,400
Statistical studies				\$ 2,272	2,272
Alaska offices			1,837	\$ 2,563	4,400
	11,350	3,999	13,172	27,239	56,760

* Includes \$2,000 transferred to Navy Department for aerial photography.

† Includes \$1,215 for clerical services.

‡ Includes \$1,000 for administrative salary and \$480 for clerical salary.

LEASING WORK

Part of the activities of the Alaskan branch are related to the proper conduct of mining work on the public mineral lands that have been leased to private individuals or corporations. Funds for this work throughout the United States are provided in a general item contained in the Interior Department appropriation act, and the amounts allotted for the different districts, including Alaska, are determined by the relative needs of each. For the fiscal year 1929 the allotment for Alaska leasing work was \$10,000. This was nominally somewhat less than heretofore but in reality was exactly the equivalent of the \$14,500 allotted in 1928, because certain work that was paid for out of the allotment in 1928 was in 1929 carried in the appropriation for the work on mineral resources.

In order that the policies and practices that have been developed by the leasing unit of the conservation branch for handling the much larger volume of similar work in the States should be maintained in Alaska and at the same time the specialized knowledge of Alaskan affairs possessed by the Alaskan branch should be utilized, the general conduct of the leasing work in Alaska is in a measure shared between the two branches, the office work in Washington being done

principally by the conservation branch and the field work by the Alaskan branch. The field work is done by the engineers assigned to the Alaska local offices, under the immediate charge of B. D. Stewart, supervising engineer, who has headquarters at Juneau, and J. J. Corey, coal-mining engineer, at Anchorage. The use of the same personnel and facilities for both the leasing work and the work on mineral resources makes it extremely difficult to distinguish accurately between the two. The point of real importance, however, is that by this plan duplication of activities is avoided, costs are lowered, and the technical facilities are focused on the main problem, which is the development of the Territory's mineral resources. At present about three-fifths of Mr. Stewart's time, all of Mr. Corey's time, and two-thirds of the time of the clerk is considered to be devoted to the leasing work. The charges for the maintenance of the local office are shared between the leasing and mineral-resources work on ratios of about 2 to 1. In the fiscal year 1929 the allotment for field expenses was approximately \$1,400, an amount that is inordinately low and that proved adequate only because the Alaska Railroad has extended to the limit its services in facilitating the movement of the engineers.

The primary purpose of the leasing work is to supervise the operations under the coal and oil leases or permits that have been granted by the Government and to advise and consult with the proper authorities, both Federal officers and private applicants, regarding lands that may be under consideration for lease or permit. Practically all the coal mining and much of the oil prospecting in Alaska is done on public lands by private individuals or companies under leases or permits issued by the Secretary of the Interior. The interest of the Government in these lands requires not only that these grants shall be a source of revenue to the Nation, but that proper methods of extracting the minerals shall be employed, thus preventing waste or damage to the property, and that the lives, health, and welfare of those engaged in the work shall be properly safeguarded. Practically all the producing coal mines that have been opened in the Territory are in the region adjacent to the Alaska Railroad. The Government has therefore an especial interest in their successful operation. For this reason the Federal engineers have given intensive study to the problems confronting these mines, to be of as much assistance as possible to the operators, by giving them competent technical advice and aiding them in making their ventures successful. Among the points to which special attention has been given are the installation and maintenance of safe and efficient mining and hoisting equipment, adequate ventilation, the reduction of explosion and blasting hazards, and the providing of adequate pillars in advance of all mining operations. This service is appreciated by the operators, and the relations between them and the engineers are extremely cordial and friendly, with no hint of the antagonism that sometimes exists between inspector and inspected.

At present drilling for oil is being done under Government permit at only one point in Alaska, and consequently little of the time of the engineers is spent in the supervision of oil developments. There are, however, many tracts of public land in Alaska that appear to hold promise of containing oil, and hundreds of prospecting permits

have been issued by the Government throughout the length and breadth of the Territory. If the staff were larger it would be easier for the engineers to check up on these permits occasionally by field visits. Under present conditions it is necessary to rely on local unofficial reports, especially as these indicate no active prospecting in progress. In this connection it should be pointed out that the number of engineers needed to look after the Government mineral lands in Alaska is not comparable with the number of engineers in certain of the States. Neither is the need to be measured by the revenues received by the Government, nor by the number of permits outstanding. In Alaska the open season is so short, distances so great, and the means of transportation so slow and uncertain that either a proportionately much larger force must be maintained or supervision in the more remote parts must be reduced to a bare gesture.

TOPOGRAPHIC BRANCH

C. H. BIRDSEYE, Chief Topographic Engineer

ORGANIZATION AND PERSONNEL

Organization of the topographic branch at the end of the year is shown below.

Chief division, Glenn S. Smith, division engineer, in charge.

1st division, W. H. Herron, division engineer, in charge.

2nd division, T. G. Gerdine, division engineer, in charge.

Chief of inspection and editing, W. M. Beaman, topographic engineer, in

charge of computing, G. W. Hawkins, geodetic engineer, acting in charge.

Chief of photographic mapping, J. H. Wheat, topographic engineer, in charge.

Chief of cartography, A. F. Hassan, cartographic engineer, in charge.

Chief of information office, J. H. Wheat, topographic engineer, in charge.

The technical force comprises the chief topographic engineer, 3 topographic engineers in charge of divisions, 25 topographic engineers, 2 geodetic engineers, 1 cartographic engineer, 139 assistants, and junior topographic, geodetic, or cartographic engineers, and 84 engineering field aides and draftsmen of various grades, a total of 255. The clerical force comprises 14 clerks.

EXPENDITURES

Receipts and expenditures for topographic surveys for the fiscal year ended June 30, 1929

State or project	Appropriation for topographic surveys	Repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Topographic surveys, 1929.....	\$505,000.00	\$133,002.13	\$638,002.13	\$476,537.34	\$1,114,539.47
Yukon National Park, 1928 and 1929.....	62,050.84	-----	62,050.84	-----	62,050.84
Denali National Park, 1929 and 1930.....	60,000.00	-----	60,000.00	-----	60,000.00
Wrangell National Park, 1928 and 1929.....	32,437.54	-----	32,437.54	-----	32,437.54
Denali National Park, 1929 and 1930.....	45,000.00	-----	45,000.00	-----	45,000.00
Alaska boundary treaty, 1928 and 1929.....	10,000.00	-----	10,000.00	-----	10,000.00
Alaska boundary treaty, 1929.....	11,800.00	-----	11,800.00	-----	11,800.00
Alaska boundary treaty.....	20,000.00	-----	20,000.00	-----	20,000.00

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1929—Continued

State or project	Appropriation for topographic surveys	Repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Welch Act.....	\$34,000.00		\$34,000.00		\$34,000.00
Total funds available.....	780,288.38	\$133,002.13	913,290.51	\$476,527.34	1,389,817.85
Expenditures:					
Alabama.....	12,091.46		12,091.46	10,000.00	22,091.46
Arizona.....	8,278.05		8,278.05		8,278.05
Arkansas.....	1,565.76		1,565.76	1,500.00	3,065.76
California.....	37,485.01	1,432.31	38,917.32	50,911.99	95,829.31
Colorado.....	7,194.95		7,194.95	2,000.00	9,194.95
Connecticut.....	3,468.97		3,468.97	4,988.27	8,457.24
Hawaii.....	27,562.63		27,562.63	24,887.55	52,450.18
Idaho.....	28,009.71		28,009.71		28,009.71
Illinois.....	46,378.05	27,199.88	73,577.93	40,015.77	113,593.70
Iowa.....	1,133.04		1,133.04	1,997.48	3,130.52
Kentucky.....	93,486.85	8,525.09	102,011.94	66,145.32	168,157.26
Maine.....	29,823.77	13,498.65	43,322.42	33,934.56	77,256.98
Michigan.....	14,629.53		14,629.53	15,053.54	29,683.07
Mississippi.....		48,962.70	48,962.70		48,962.70
Missouri.....	7,486.62		7,486.62	6,288.32	13,774.94
Montana.....	2,769.02		2,769.02	15,626.92	18,395.94
Nevada.....	32.05	4,797.42	4,829.47		4,829.47
New Hampshire.....	14,736.03		14,736.03	33,677.90	48,413.93
New Mexico.....	13,868.86		13,868.86	12,728.85	26,595.71
New York.....	6,098.81		6,098.81	10,424.50	16,523.31
North Dakota.....	8,694.39		8,694.39	12,965.09	21,659.48
Oklahoma.....	16,690.31		16,690.31	15,566.73	32,257.04
Oregon.....	11,345.82		11,345.82	1,735.17	13,080.99
Pennsylvania.....	15,211.13		15,211.13	22,456.46	37,677.59
Tennessee.....	72,920.44		72,920.44	14,000.00	86,920.44
Texas.....	36,418.51	4,531.63	40,950.14	33,867.41	74,817.55
Utah.....	7,421.02		7,421.02	329.44	7,750.46
Vermont.....	13,925.03	4,029.51	17,954.54	8,184.73	26,139.27
Virginia.....	68,796.74	3,012.03	71,807.77	12,020.04	83,827.81
Washington.....	8,618.73		8,618.73	3,367.98	11,986.71
West Virginia.....	203.78		203.78		203.78
Wisconsin.....	13,431.98	6,329.47	19,761.45	15,855.32	35,616.77
Wyoming.....	708.68		708.68		708.68
Books for library.....	157.39		157.39		157.39
Computing.....	* 4,207.53		4,207.53		4,207.53
Contingent.....	11,176.74		11,176.74		11,176.74
Field distribution offices.....	600.00		600.00		600.00
Instruments (field).....	* 8,137.10		8,137.10		8,137.10
Stationery (field).....	* 225.00		225.00		225.00
Inspection and editing.....	* 8,887.42		8,887.42		8,887.42
Map information.....	3,496.36		3,496.36		3,496.36
One-millionth maps.....	7,747.64		7,747.64		7,747.64
Miscellaneous repay.....		10,683.44	10,683.44		10,683.44
Office salaries.....	* 8,742.64		8,742.64		8,742.64
Photographic mapping.....	* 3,939.81		3,939.81		3,939.81
Relief maps.....	3.85		3.85		3.85
Total expenditures *.....	687,801.21	133,002.13	820,803.34	476,527.34	1,297,335.68
Unexpended balance *.....	92,487.17		92,487.17		92,487.17
	780,288.38	133,002.13	913,290.51	476,527.34	1,389,817.85

* Represents 37.5 per cent of total cost; balance of 62.5 per cent included in charges for State cooperation.

* \$452,541.39 expended on State cooperation.

* Includes \$57,945.84 Great Smoky and \$33,024.78 Shenandoah Park funds available during fiscal year 1930.

GENERAL OFFICE WORK

General office work consisted in the inking and inspection and editing of the topographic field sheets prior to their submission for reproduction, the computation and adjustment of the results of control field work, and the preparation of partial culture and drainage basins from aerial photographs. A base map of California was prepared, and the base map of Arkansas was revised. A partial





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culture and drainage base map of the Tensas Basin, Louisiana and Arkansas, was compiled for the Mississippi River Commission. Cooperation with the Air Corps, United States Army, was continued whereby aerial photographs were furnished for use in topographic mapping. (See also p. 80, "Inspection and editing of topographic maps.")

SUMMARY OF RESULTS

The condition of topographic surveys to June 30, 1929, is shown on Plate 1. The status of topographic surveys is further shown in the following table:

New topographic surveys of the United States, July 1, 1928, to June 30, 1929, and total area surveyed in each State

State	Publication contour interval (feet)	Mapped in fiscal year (square miles) for publication on scale of 1 to					Total area mapped in fiscal year (square miles)			Percentage of total area of State mapped to June 30, 1929	River surveys, scale 1:20,000 (linear miles)	Spirit levels (miles)	Transit traverse (miles)	Triangulation stations occupied
		12,000	20,000	24,000	31,680	62,500	125,000	Revis- ion	Resur- vey					
Alabama.....	20					457	480		251	21,491		65	34	
Arizona.....	100								480	58,358		92		
Arkansas.....	10									21,730	10	239		
California.....	5, 20, 25			294	555			46	810	125,021		993		100
Colorado.....	25, 50	20		14		17			34	55,547		3	223	
Connecticut.....										4,965				
Delaware.....										2,370				
District of Columbia.....										70				
Florida.....										4,716				
Georgia.....	2, 100									24,835				
Idaho.....	5, 10, 20	61					300		61	20,746		8		
Illinois.....	5, 10, 20					1,330			143	31,700	124	548	1,151	
Indiana.....	5, 20					3			3	3,068	114	219	170	
Iowa.....	5, 20					144			144	13,167				
Kansas.....										64,159				
Kentucky.....	20					2,004			2,004	26,236	172	700	1,067	
Louisiana.....										8,323				36
Maine.....	20					1,071			1,071	14,405		354	43	
Maryland.....										12,327				
Massachusetts.....										8,264				
Michigan.....	5, 10, 20					546			546	13,484				
Minnesota.....	5, 10, 20									7,354				
Mississippi.....	2, 5, 10, 20					104			104	2,955	196	496	313	
Missouri.....	20					238			238	42,033		193	280	
Montana.....	2, 5	57							57	41,891		88		5
Nebraska.....										27,117				
Nevada.....	2, 5	5							18	44,642		18		4
New Hampshire.....	20					864			864	8,021		268	23	2
New Jersey.....										8,224				
New Mexico.....	20, 25, 50, 100			33			1,318	33	913	41,915		387		9
New York.....	20					239			239	49,204		83		
North Carolina.....	20			70		6			70	19,040		281	247	15
North Dakota.....	20					887			887	13,076		224		
Ohio.....										41,040				
Oklahoma.....	10, 20					1,073	1,112	249	524	31,208	12			
Oregon.....	100									31,763		135		
Pennsylvania.....	20					886			1,112	35,763		259	267	
Rhode Island.....									22	1,248				
South Carolina.....										13,737				

	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	Total
South Dakota.																
Tennessee.....	20	370	90	316	133	10,243	24.8	497	340	14						
Texas.....	1,410	737	15	752	752	22,380	55.6	497	340	14						
Utah.....	50	6	6	6	6	87,367	32.9	114	550	11						
Vermont.....	10,20	128	128	128	128	19,103	22.5	232	232							
Virginia.....	20	306	244	504	45	7,495	78.4	* 204	745	343						
Washington.....	100	440	440	440	440	37,749	88.6	61	265							
West Virginia.....						26,374	51.2									
Wisconsin.....	10,20	510			510	24,170	100.0									
Wyoming.....						18,849	32.7									
						30,374	31.0									
Total continental United States (exclusive of Alaska).																
Hawaii.....	10.50	266	364	328	266	1,320,939	43.6	838	8,520	196						
						6,265	97.6	22		15						

- Mapped on scale of 1:4,800.

200 miles mapped on scale of 1:24,000; 3 miles on 1:1,200; 1 mile on 1:2,400.

* Advance sheet editions in 10-foot contours; final publication in 50-foot contours and on a scale of 1:62,500.

FIELD SURVEYS

Alabama.—In cooperation with the State geologist of Alabama the survey of the Epes quadrangle was completed and the resurvey of the Searles quadrangle was completed and that of the Cottondale quadrangle (previously surveyed on a smaller scale) was continued.

Arizona.—At the request of the Forest Service the resurvey of the Turret Peak quadrangle (previously surveyed on a smaller scale) was continued.

Arkansas.—In cooperation with the United States Army district engineer, Vicksburg, Miss., the survey of the Ouachita River from Arkadelphia to Fairview was completed.

California.—In cooperation with the State engineer of California the resurvey of the Rosedale, Fairfax School, Rio Bravo, Buttonwillow, Coles Levee, No. 69, and Gosford quadrangles was completed, and that of the Bena, Stevens, No. 68, No. 70, Treves, Waits, Millux, and Treadwell quadrangles was begun (areas previously surveyed on a smaller scale). In cooperation with the county surveyor of Los Angeles County the resurvey of the Dry Canyon, Las Flores, Vejar, Zelzah, Newhall, Solstice Canyon, Chatsworth, Pico, Arroyo Sequis, and Russell Valley quadrangles was completed; that of the Sylmar quadrangle was continued; that of the Dume Point and Del Valle quadrangles was begun (areas previously surveyed on a smaller scale); and the culture was revised on the previously surveyed parts of the Dry Canyon and Zelzah quadrangles.

Colorado.—In cooperation with the Colorado Metal Mining Fund the resurvey of the Ouray mining district, the Mosquito Range mining region, and the Telluride mining district was continued. At the request of the Forest Service the survey of the Mount Powell No. 4 quadrangle was begun.

Connecticut.—In cooperation with the attorney general of Connecticut the culture and drainage of the Broad Brook, Cromwell, East Hampton, Glastonbury, Middletown, Manchester, Long Meadow, Rocky Hill, Windsor, and Windsor Locks quadrangles (previously surveyed on a smaller scale) was partly revised by means of aerial photography.

Hawaii.—In cooperation with the commissioner of public lands of the Territory of Hawaii the survey of the Schofield, Mokapu, Waiānae, Kaneohe, and Koko Head quadrangles was completed, that of the Wahiawa quadrangle was continued, and that of the Laie, Kaena, Kaaawa, Kaipapau, Kahana, and Haleiwa quadrangle was begun.

Idaho.—At the request of the geologic branch the survey of the Bayhorse quadrangle was continued. At the request of the State Department the survey of the Kootenai River was completed.

Illinois.—In cooperation with the Department of Registration and Education of Illinois, Geological Survey, the survey of the Mackinaw, Chandlerville, Meredosia, Barry, Hannibal, Thebes, Wickliffe, and Mound City quadrangles and the Salem-Mount Vernon and Shelbyville-Altamont highway projects were completed, that of the Arenzville and Hettick quadrangles was continued, and that of the Keokuk, Fort Madison, Annawan, Virginia, Prophetstown, Rose Hill, Decatur, and Effingham quadrangles and Mulberry Grove project was begun. The resurvey of the Geneva quadrangle was continued. In cooperation with the United States Army district engineer, Chicago, the survey of the Kankakee River from Wilmington to the Indiana State line, of the Sangamon River from Chandlerville to Mahomet, and of Salt Creek from the mouth to Rankin Bridge was completed.

Indiana.—In cooperation with the United States Army district engineer, Chicago, the survey of the Kankakee River from Brems to the Illinois State line, of the Whitewater River from Connersville to the Ohio State line, and of the East Fork of the Whitewater River from Brownsville to the mouth was completed. The survey of the La Grange quadrangle was completed.

Iowa.—In cooperation with the Geological Survey of Iowa the survey of the Indianola quadrangle was completed.

Kentucky.—In cooperation with the State geologist of Kentucky the survey of the Burnside, Hardinsburg, Eddyville, Pleasureville, Morehead, Barthell, Higgsport, Felicity, Red Boiling Springs, Corydon, Lawrenceburg, Lafayette, La Center, Adolphus, and Cannelton quadrangles and the Blue Lick Battleground was completed and that of the Cynthiana, Somerset, Falls of Rough, Sadleville, and Sunnybrook quadrangles was begun. In cooperation with the United States Army district engineer, Cincinnati, the survey of the Licking River from the mouth to Cave Run was completed.

Maine.—In cooperation with the Public Utilities Commission of Maine the survey of the Stratton, Spencer, Winterville, and Eagle Lake quadrangles was completed, that of the Great Pond quadrangle was continued, and that of the Beddington, Winchell, Caribou, and Brooks quadrangles was begun. In cooperation with the War Department the survey of the Chain Lakes and Skinner quadrangles was completed.

Maine-New Hampshire.—In cooperation with the Highway Commission of Maine and the Highway Department of New Hampshire a survey of the boundary between these two States north of the outlet of Great East Pond was continued.

Michigan.—In cooperation with the Department of Conservation of Michigan, Geological Survey, the survey of the Fennville quadrangle was completed, that of the Fletcher quadrangle was continued, and that of the Muskegon, Holland, Twin Lake, and Shepherd quadrangles was begun.

Mississippi.—In cooperation with the United States Army district engineer, Vicksburg, Miss., the survey of the Yazoo River from Yazoo City to Greenwood, of the Tallahatchie River from Greenwood to the Tallahatchie County line, of the Yalobusha River from Holcomb to Sabougla Creek, of the Skunka River from the mouth to the Calhoun County line, of the Coldwater River from Coldwater to Miller, and of the Little Tallahatchie River from Batesville to Abbeville was completed.

Missouri.—In cooperation with the State geologist of Missouri the resurvey of the McCredie quadrangle was completed and that of the Mexico No. 3 quadrangle was begun (areas previously surveyed on a smaller scale).

Montana.—At the request of the geologic branch the survey of the Libby quadrangle was continued. In cooperation with the State engineer of Montana the survey of the Flathead Lake project was completed.

Nevada.—At the request of the Navy Department the resurvey of a part of the Hawthorne quadrangle was completed.

New Hampshire.—In cooperation with the Highway Department of New Hampshire the survey of the Rumney, Plymouth, and Wonalancet quadrangles was completed and that of the Sugar Hill, Franconia, Partridge Pond, and Thetford quadrangles was begun.

New Mexico.—In cooperation with the State engineer of New Mexico the survey of the Talpa quadrangle was completed and the resurvey of the Kirtland quadrangle was completed and that of the Crozier, Talpa, Shiprock, and Stony Butte quadrangles was begun (areas previously surveyed on a smaller scale). At the request of the geologic branch the revision of the Santa Rita quadrangle was completed.

New York.—In cooperation with the Department of Public Works of New York the resurvey of the Amsterdam quadrangle was completed and the resurvey of the Ramapo, Schunemunk, and Kinderhook quadrangles was begun.

North Carolina.—The survey of the tentative boundary of the proposed Great Smoky Mountains National Park was begun, and that of the Stuart quadrangle was completed.

North Dakota.—In cooperation with the State engineer of North Dakota the survey of the Devils Lake, Tokio, Oberon, Grahams Island, and Flora quadrangles was completed and that of the Upham quadrangle was begun.

Oklahoma.—In cooperation with the State Highway Commission of Oklahoma the survey of the Yale, Skedee, Stroud, Fairfax, and Ripley quadrangles and the cultural revision of previous work on the Drumright and Stroud quadrangles was completed.

Oklahoma-Texas.—In cooperation with the United States Army district engineer, Vicksburg, Miss., the survey of the Red River in the vicinity of Ryan, Okla., was completed.

Oregon.—In cooperation with the State engineer of Oregon the survey of the Madras quadrangle was completed and that of the Pendleton quadrangle was begun. At the request of the Forest Service the survey of the Mount Washington quadrangle was begun.

Pennsylvania.—In cooperation with the Department of Internal Affairs of Pennsylvania, Topographic and Geologic Survey, the survey of the Ariel, Snowshoe, and Corry quadrangles was completed and that of the Clearfield, Penfield, Union City, and Karthaus quadrangles and a resurvey of the Tyrone quadrangle was begun.

Tennessee.—In cooperation with the State geologist of Tennessee the survey of the Monoville quadrangle and the resurvey of the Nashville special quad-

range (previously surveyed on a smaller scale) was completed. The survey of the tentative boundary of the proposed Great Smoky Mountains National Park was begun.

Texas.—In cooperation with the county commissioners of Cameron County the survey of the Lyford No. 4, Harlingen No. 1, and Harlingen No. 2 quadrangles was completed and that of the Fernando No. 3, Fernando No. 4, Mercedes No. 1, and Harlingen No. 3 quadrangles was begun. In cooperation with the county commissioners of Galveston County the survey of the Seabrook, Trinity Bay, Genoa, Alcoa No. 1, Alcoa No. 2, Alcoa No. 3, Alcoa No. 4, Galveston No. 2, Galveston No. 3, and San Luis Pass No. 1 quadrangles was completed and the survey of the High Island No. 3, Round Point No. 3, Round Point No. 4, Patton No. 1, Patton No. 2, Patton No. 3, Galveston No. 1, Galveston No. 4, Lake Como No. 2, San Luis Pass No. 4, and Smith Point No. 4 quadrangles and the southeastern parts of the Galveston No. 3, San Luis Pass No. 1, and Trinity Bay quadrangles was completed by means of aerial photography. In cooperation with the Board of Water Engineers of Texas the survey of the Archer City 3-a and Archer City 4-b quadrangles was begun. At the request of the Bureau of Mines the survey of the Cliffside structure area was completed.

Utah.—At the request of the National Park Service the survey of the Zion National Park was begun.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Townshend and Ludlow quadrangles was begun. In cooperation with the Vermont Flood Control Commission the survey of parts of the Passumpsic, Moose, and White Rivers and the North Branch of the Winooski River, the Stevens Branch, and Bolton Falls and vicinity was completed. In cooperation with the United States Army district engineer, New York, the survey of parts of the Winooski, Kingsbury, and Lamolle Rivers was completed.

Virginia.—In cooperation with the Conservation and Development Commission of Virginia, Geological Survey, the survey of the Stuart quadrangle was completed, the resurvey of the University and Barber quadrangles was completed, and that of the Bonsacks and Salem quadrangles was continued (areas previously surveyed on a smaller scale). The survey of the tentative boundary of the proposed Shenandoah National Park was completed.

Washington.—In cooperation with the Department of Conservation and Development of Washington the survey of the Colville quadrangle was continued.

Wisconsin.—In cooperation with the Geological and Natural History Survey of Wisconsin the survey of the Alma and Minnellska quadrangles was completed, that of the Mondovi and Montana quadrangles was continued, and the culture and drainage of the Three Lakes quadrangle were compiled from aerial photographs. In cooperation with the United States Army district engineer, St. Paul, and the Geological and Natural History Survey of Wisconsin the survey of the Durand quadrangle was continued and that of the Wabasha, Arkansasaw, Chippewa Falls, Elk Mound, and Menomonie quadrangles was begun.

WATER-RESOURCES BRANCH

N. C. GROVER, *Chief Hydraulic Engineer*

ORGANIZATION AND PERSONNEL

The work of the water-resources branch has been administered through the year by the following units:

Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.

Division of ground water, O. E. Meinzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

The technical force at the end of the year comprises the chief hydraulic engineer, 1 principal hydraulic engineer, 29 senior hydraulic engineers, 10 hydraulic engineers, 117 associate, assistant, and junior engineers; 3 senior geologists, 7 associate, assistant and junior geologists; 1 senior chemist, 5 associate, assistant, and junior chemists—a total of 174. The clerical force comprises 31 clerks. The changes in personnel during the year show a net increase of 51.

FUNDS

The funds available for Geological Survey work on water resources were as follows:

Gaging streams.....	\$270,500.00
Transfers from Federal agencies.....	157,210.00
Repayments by Federal agencies.....	217,178.00
Funds furnished by States and other non-Federal governmental agencies.....	367,929.66
Funds furnished by permittees and licensees of the Federal Power Commission.....	31,251.00

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Alabama.....	\$2,925.37
Arizona.....	18,127.03
Arkansas.....	6,400.16
California:	
State.....	\$32,505.54
Municipal.....	20,643.18
	53,148.72
Colorado.....	496.53
Connecticut.....	6,040.58
Florida.....	210.00
Hawaii:	
Territory.....	29,507.29
Municipal.....	5,418.56
	34,925.85
Idaho.....	17,562.93
Illinois.....	3,926.38
Kansas.....	3,254.37
Kentucky.....	100.00
Maine.....	5,265.59
Maryland.....	922.84
Massachusetts.....	4,222.82
Minnesota.....	372.48
Missouri.....	8,929.14
Montana.....	13,128.08
Nevada.....	672.66
New Hampshire.....	1,592.46
New Jersey.....	11,702.15
New Mexico.....	4,126.20
New York.....	18,219.22
North Carolina:	
State.....	10,462.24
Municipal.....	5,638.70
	16,100.94
Ohio.....	23,865.33
Oregon:	
State.....	5,311.32
Municipal.....	1,399.98
	6,711.30
Pennsylvania.....	3,032.93
Tennessee.....	19,559.65

Texas.....	\$30, 707. 50
Utah.....	6, 042. 02
Vermont.....	8, 003. 58
Virginia.....	17, 575. 48
Washington:	
State.....	\$4, 084. 19
Municipal.....	1, 031. 85
	<hr/>
West Virginia.....	5, 116. 04
Wisconsin.....	395. 05
Wyoming.....	6, 484. 79
	<hr/>
	8, 063. 49
	<hr/>
	367, 929. 66

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects was continued in cooperation with the Bureau of Reclamation on the Black Canyon project and on the lower Colorado River. A supplemental study has been begun for the Bureau of Reclamation of the change of conditions at the Avalon Dam of the Carlsbad irrigation project in New Mexico.

Indian Service.—Stream gaging was continued for the Indian Service in the Colville, Western Shoshone, and Walker River Reservations and on the Gila and San Carlos Rivers. Examinations were made of available sources of ground-water supplies for the Haskell Institute in Kansas, for the White Earth Indian Agency and School in Minnesota, for Tesuque Pueblo in New Mexico, and for the Standing Rock Indian Agency and School in North Dakota.

National Park Service.—Streams in the Yellowstone National Park were measured during the year at stations maintained in cooperation with the National Park Service.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service.

Weather Bureau.—Stream gaging has been continued on the Colorado River in Arizona in cooperation with the Weather Bureau.

Department of State.—Stream gaging and investigations concerning water utilization and flood-control problems have been continued on the Rio Grande on the Mexican boundary and on numerous streams on and near the Canadian boundary from the Lake of the Woods westward. Notable centers of activity on the Canadian boundary have been the Roseau River in Minnesota, the St. Mary and Milk Rivers in Montana, and the Kootenai River in Idaho. Some of these operations on the Canadian boundary are being conducted jointly with Dominion officials because of the common interest of the two countries therein, and negotiations are in progress for extending the scope of such operations. The cost of this work is being met by funds transferred to the Geological Survey by the Department of State.

Corps of Engineers, United States Army.—During the fiscal year stream gaging has been in progress in cooperation with the Corps of Engineers in connection with flood control and with studies and reports to be made under House Document 308 of the Sixty-ninth Congress, first session. This cooperation has been arranged with the district engineers of the Army at Boston, Providence, New York, Philadelphia, Washington, Norfolk, Huntington, Wilmington, Chat-

tanooga, Nashville, Florence, Montgomery, Mobile, Galveston, Jacksonville, Vicksburg, Louisville, Cincinnati, St. Paul, Kansas City, Seattle, Portland, and San Francisco and includes about 520 gaging stations. The cost of this work is met by transfers from the funds of the Corps of Engineers.

Federal Power Commission.—The stream gaging required by the Federal Power Commission in permits and licenses issued for the development of water power under the Federal water-power act has been performed or supervised by engineers of the Geological Survey in Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Iowa, Indiana, Kentucky, Maine, Michigan, Minnesota, Missouri, Montana, New Mexico, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming. The operation of constructed projects or those under construction has been supervised in Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wisconsin, and Wyoming.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 15 reports and 6 separate chapters. (See p. 4.) At the end of the year 19 other reports were in press, and 16 were awaiting funds for publication.

CHARACTER AND METHOD OF WORK

The study of surface waters, which consists primarily of the measurement of the flow of streams, has been conducted in 47 States and Hawaii at selected gaging stations at which the volume of water carried by the streams is measured and records of stage and other data, from which the daily flow of the stream is computed, are collected. At the end of the year 2,238 gaging stations were being maintained; 257 stations were discontinued and 665 new stations established during the year. Records for about 96 additional stations were received, ready for publication, from Government bureaus and private persons, and a number of Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

The division of ground water investigates the waters that lie below the surface; their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to the chemical composition of the water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects. During the

fiscal year about 45 investigations relating to ground water and reservoir sites were in progress, and work was conducted in 24 States. The demands of the public for precise information in regard to ground-water resources are becoming more and more exacting with increasing need for the water. In recent years considerable research into the principles of ground-water hydrology has been undertaken in the division in order to provide a more secure basis for ground-water investigations.

A series of papers on methods of estimating ground-water supplies was presented at the New York meeting of the Society of Economic Geologists in December, 1928, as follows: Outline of available methods, by O. E. Meinzer; Methods based on transpiration of plants, by W. N. White; Methods applicable to artesian basins, by D. G. Thompson. O. E. Meinzer, Kirk Bryan, and H. T. Stearns presented papers in a symposium on the geology of reservoir and dam sites at the meeting of the American Institute of Mining and Metallurgical Engineers in New York in February, 1929. Abstracts of papers relating to ground-water hydrology were prepared for the Annotated Bibliography of Economic Geology and for foreign abstract journals.

A. G. Fiedler was assigned, with headquarters at Minneapolis, to undertake a comprehensive study of well-drilling methods and to cooperate with the several State associations of water-well drillers. He took part in the annual meetings of seven of these State associations and assisted in the organization of a national association.

The work on quality of water involved the examination of 1,037 samples of water with reference to their dissolved mineral matter and 245 samples of silt taken in connection with the study of the silt carried by streams. The samples analyzed included some for nearly all the studies of ground water in the different States as noted below. Results for an additional year were added to manuscripts previously prepared by C. S. Howard on dissolved matter and suspended matter in the Colorado River. The report on dissolved matter for 1926-1928 was issued as Water-Supply Paper 636-A.

The work of the division of power resources comprised the preparation of monthly and annual reports of the production of electricity and consumption of fuel by public-utility power plants, a report of the developed water power of the United States, and compilations of the stocks of coal held by electric public-utility power plants for inclusion in reports of commercial stocks of coal undertaken quarterly by the Bureau of Mines of the Department of Commerce. The monthly and annual figures of output of electricity and fuel consumption are based on reports submitted by concerns producing electricity for public use. On January 1, 1929, 1,720 companies, operating 3,795 power plants with a total capacity of generators of 29,630,000 kilowatts, were on the list of companies requested to submit reports of the operation of their power plants. Plants whose output is less than 10,000 kilowatt-hours a month are not included. Reports are received from plants representing over 95 per cent of the capacity of all plants listed. The output of plants not reporting is estimated.

Annual production of electricity by public-utility power plants in the United States, 1919-1928

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from preceding year	Kilowatt-hours	Per cent of total	Change from preceding year	Kilowatt-hours	Per cent of total	Change from preceding year
		<i>Per cent</i>			<i>Per cent</i>			<i>Per cent</i>
1919.....	38,921,000,000		14,606,000,000	37.5		24,315,000,000	62.5	
1920.....	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921.....	40,975,000,000	-5.9	14,970,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922.....	47,654,000,000	+16.3	17,207,000,000	36.1	+14.9	30,447,000,000	63.9	+17.1
1923.....	55,665,000,000	+16.8	19,343,000,000	34.8	+12.4	36,322,000,000	65.2	+18.3
1924.....	59,014,000,000	+6.0	19,969,000,000	33.8	+3.2	39,044,000,000	66.2	+7.5
1925.....	65,870,000,000	+11.6	22,356,000,000	33.9	+11.9	43,514,000,000	66.1	+11.4
1926.....	73,791,000,000	+12.0	26,189,000,000	35.5	+17.1	47,602,000,000	64.5	+9.4
1927.....	80,205,000,000	+8.7	29,875,000,000	37.2	+14.1	50,330,000,000	62.8	+5.7
1928.....	87,850,000,000	+9.5	34,696,000,000	39.5	+16.1	53,154,000,000	60.5	+5.6

Annual consumption of fuel in the production of electricity by public-utility power plants in the United States, 1919-1928

Year	Coal		Fuel oil		Gas	
	Short tons	Change from preceding year	Barrels	Change from preceding year	M cubic feet	Change from preceding year
		<i>Per cent</i>		<i>Per cent</i>		<i>Per cent</i>
1919.....	35,100,000		11,050,000		21,406,000	
1920.....	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921.....	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.0
1922.....	34,179,000	+8.2	13,197,000	+9.6	27,172,000	+14.5
1923.....	38,966,000	+14.0	14,684,000	+11.3	31,483,000	+15.9
1924.....	37,556,000	-3.6	16,630,000	+13.3	48,443,000	+53.9
1925.....	40,222,000	+7.1	10,246,000	-38.4	46,521,000	-4.0
1926.....	41,311,000	+2.7	9,399,000	-8.3	53,207,000	+14.4
1927.....	41,888,000	+1.4	6,782,000	-27.8	62,919,000	+18.3
1928.....	41,350,000	-1.3	7,188,000	+5.5	77,326,000	+22.9

The remarkable improvement each year in the utilization of fuel in the generation of electricity by public-utility companies continues, as indicated in the following table:

Average consumption of coal^a per kilowatt-hour by public-utility power plants in the United States, 1919-1928

Year	Pounds	Per cent of rate in 1919	Year	Pounds	Per cent of rate in 1919
1919.....	3.2	100	1924.....	2.2	69
1920.....	3.0	94	1925.....	2.1	66
1921.....	2.7	84	1926.....	1.95	61
1922.....	2.5	78	1927.....	1.84	57
1923.....	2.4	75	1928.....	1.76	55

^a Oil and gas included as equivalent coal.

If there had been no improvement in the utilization of fuel subsequent to 1919 about 180,000,000 tons more of coal would have been consumed in generating electricity from 1920 to 1928. The produc-

tion of electricity by the use of water power continues to show a greater proportional increase over that produced by the use of fuel, notwithstanding the increase in efficiency of fuel-burning plants.

A report of the amount of developed water power in the United States on January 1, 1929, was released February 8, 1929, and the final report of the annual production of electricity by public-utility power plants in 1928 was released May 27, 1929.

The investigation of the water-power and irrigation resources of the public lands has been continued during the year in areas designated and with the use of funds provided by the conservation branch. The work has been done by a small personnel working from two field offices, one of which was discontinued early in the year. It has consisted of the examination of streams, including the location and survey of power and reservoir sites and of neighboring lands to determine their value for power or irrigation, and the preparation of reports, either for office use or for publication, on the power value of streams.

WORK OF THE YEAR BY STATES

The following table shows by States the number of gaging stations maintained for the collection of stream-flow records and the interest in those stations of the agencies cooperating with the Geological Survey:

Gaging stations and cooperating parties for the year ended June 30, 1939

State or Territory	Geological Survey alone	Bureau of Reclamation	Forest Service	Indian Service	Army Engineers	Weather Bureau	Other Federal bureaus	State cooperation	Municipal cooperation	Private persons	Counted more than once	Maintained at end of year	Established during year	Discontinued during year	Regular gaging during year	Miscellaneous gaging during year
Alabama					23			2		7	2	30	11	2	215	2
Arizona		1		3				49			4	49	9	3	1,459	45
Arkansas					4			11		11	4	10	9	3	1,142	6
California					1	4		232	72	95	196	234	25	16	3,180	341
Colorado		2	20	1			5	14	3	6	5	14	15	14	240	11
Connecticut					12			5		3	1	10	8		124	
Delaware					3											
Florida					6					8	5	9	4	2	65	26
Georgia					13					8	1	20	12		98	17
Idaho		6	8		9	2	38	104	5	200	90	262	131	120	2,317	96
Illinois					7	2		34	1	2	12	34			100	
Indiana					13			10		1	11	12	7	1	34	1
Iowa					4				1		1	5	5		216	4
Kansas					21	4		35		2	6	46	46	1	112	13
Kentucky					22					9	8	23	3	1	34	
Louisiana					4							4	4		169	
Maine					13			18		8	14	26	9	1	67	
Maryland					6				5		1	12	3		136	
Massachusetts	2							20		1	1	20	1		10	
Michigan								6	1	1		2	1		183	1
Minnesota					22		12			4		44	31		174	3
Mississippi					11					3		11	15	4	404	3
Missouri					13	6		63		24	30	76	26	8	530	20
Montana		2			32		32	34		12		112	41	6	160	
Nebraska					1					14		14	14		19	
Nevada				1				15		7	8	15			83	
New Hampshire					7			15		12	12	22	4	1	219	15
New Jersey						1		41	9	6	16	41	2		98	
New Mexico							1								583	2
New York					9			90	2	49	60	90	10	3	408	22
North Carolina					28			67	21	18	61	66	21	4	33	
North Dakota					8							8	4		542	9
Ohio					1	3		99	14	5	28	99	4	3	25	
Oklahoma					30					2	84	84	28	38	440	75
Oregon			1		6					6	3	10	1		86	6
Pennsylvania					6				9	37		6	1	2	34	1
Rhode Island					1							6			132	3
South Carolina					1							18	17		389	27
South Dakota					18							60	11		1,760	96
Tennessee					87	4				10	71	60	1		1,163	8
Texas					1	11	17	94	14	19	21	113	11	4		
Utah	1	3					1	59		19		64	3	4		

Gaging stations and cooperating parties for the year ended June 30, 1929—Continued

State or Territory	Geolog- ical Survey alone	Bureau of Recla- mation	Forest Service	Indian Service	Army Engi- neers	Weather Bureau	Other Federal bureaus	State cooper- ation	Municipal cooper- ation	Private persons	Counted more than once	Maintained at end of year	Estab- lished during year	Discon- tinued during year	Regular gagings during year	Miscel- laneous gagings during year
Vermont					3			13		13	7	22	15		118	
Virginia					5			63	6	13	19	68	12		186	151
Washington					44			95	20	39	94	113	50		598	91
West Virginia			1	4				2	1	9		41	20		191	20
Wisconsin					29			37		11	13	38	2		176	7
Wyoming					3			30		3	6	58	17		226	30
Hawaii					14	1	7	79	7	27	34	70	3	8	433	348
	3	19	30	13	521	46	117	1,567	192	698	968	2,238	665	257	17,302	1,508

Alabama.—A systematic survey of the ground-water resources of Alabama was undertaken in cooperation with the State Geological Survey. Field work was done in 11 counties by W. D. Johnston, jr., who prepared reports on these counties. Gaging stations were established on the Tuscumbia and Huntsville Springs.

Arizona.—In connection with the supervision of investigational work and construction under permits and licenses of the Federal Power Commission, examination is in progress for the commission of several minor projects to develop power on the Colorado River and its tributaries.

Arkansas.—In cooperation with the Arkansas State Geological Survey, a study of the source and quantity of the ground-water supply used for irrigation of rice in the area about Stuttgart was undertaken by D. G. Thompson.

California.—Water levels were measured in selected wells in southern California under the direction of F. C. Ebert. The record now covers a period of 25 years. Work was continued, with financial support by the East Bay Municipal Utility District, on an investigation of the ground water in the alluvial fan of the Mokelumne River, by H. T. Stearns, T. W. Robinson, and G. H. Taylor. A manuscript report giving the records of wells, ground-water levels, pumpage, and irrigation areas was released by filing it in the public library at Lodi. A manuscript report was prepared on the power classification of lands in the Cow and Clover Creek Basins, for office use.

Colorado.—A report on the upper Colorado River and its utilization, by Robert Follansbee, is in press as Water-Supply Paper 617.

Idaho.—The study of ground-water conditions in the Snake River Basin and their relation to large springs and stream flow was continued by H. T. Stearns, Lynn Crandall, W. G. Stewart, and J. L. Saunders. A paper on the Craters of the Moon National Monument, by Mr. Stearns, published as Bulletin 13 of the Idaho Bureau of Mines and Geology, was a by-product of the investigations in the Snake River Basin. It contains 57 pages, a sketch map, and 20 page plates consisting of views of the monument. A report on ground water for irrigation in the Raft River Valley, by Mr. Stearns, was released to the public in manuscript form. A brief examination and report were made by Messrs. Meinzer and Stearns on the Joy reservoir site, on the South Fork of the Boise River. The ground-water work in Idaho is conducted in cooperation with the Idaho Department of Reclamation and the Idaho Bureau of Mines and Geology.

Illinois.—A. G. Fiedler attended the annual meeting of the Illinois State Association of Water-Well Drillers and presented a paper on cementing methods used in well construction.

Iowa.—A. G. Fiedler cooperated with the State geologist of Iowa in the organization of a State well-drillers' association.

Kansas.—An examination of the prospects of obtaining a water supply from wells for the Haskell Institute, Lawrence, Kans., was made by W. N. White, and a report thereon was submitted to the Indian Service.

Kentucky.—A brief examination of ground-water conditions in the vicinity of Madisonville, Ky., was made by W. D. Johnston, jr.

Maryland.—An examination was made by S. S. Nye of the available supply of ground water at the District of Columbia training school at Laurel, Md.

Michigan.—A. G. Fiedler cooperated with the State geologist of Michigan in the organization of a State well drillers' association.

Minnesota.—A branch office was established in Minneapolis in charge of A. G. Fiedler, who undertook a thorough study of well-drilling methods in Minnesota and other States and cooperated with the several State associations of water-well drillers. An examination of the available sources of water supply for the White Earth Indian Agency and School was made by H. E. Simpson, who prepared a report on the subject that was transmitted to the Indian Service.

Montana.—The study of ground-water levels in an area north of Flathead Lake, Mont., in relation to fluctuations in the lake level was continued by A. H. Tuttle, and a preliminary report thereon was transmitted to the Federal Power Commission. Work was continued on the geology and ground-water resources of Big Horn County by W. T. Thom, jr., and G. M. Hall.

Nebraska.—A. G. Fiedler cooperated with the Nebraska State Geological Survey in the organization of a State well drillers' association.

New Jersey.—A report entitled "Ground-Water Supplies of the Atlantic City Region," by D. G. Thompson, was published by the New Jersey Department of Conservation and Development as Bulletin 30. It contains 184 pages, 7 plates, and 23 text figures. Similar reports on the ground-water supplies in the

vicinity of Asbury Park and in the Camden region were completed by Mr. Thompson and transmitted to the Department of Conservation and Development for publication. A report on the ground-water supplies of the Passaic River Valley was also nearly completed. Measurements on numerous observation wells were continued by H. C. Barksdale, of the Department of Conservation and Development. Determinations of chloride are being made regularly on samples from several wells in and near Atlantic City.

New Mexico.—Investigation of the ground-water resources of different parts of New Mexico was continued in cooperation with the State engineer. The following reports, prepared by the United States Geological Survey, were published in the eighth biennial report of the State engineer:

Fiedler, A. G., and Nye, S. S., Ground-water investigation of the Roswell artesian basin, pp. 81–107, 5 plates.

Fiedler, A. G., Report on a reconnaissance of the ground-water area of the Mimbres Valley, Luna County, pp. 159–171.

Nye, S. S., Geology of the Cactus Flat reservoir site for the Hope Community, pp. 179–188, 1 plate.

Bryan, Kirk, State of New Mexico Middle Rio Grande Conservancy District, Geology of the State Line dam site, pp. 253–258.

The final report on the geology and ground-water resources of a part of Sandoval County, by B. C. Renick, was transmitted for publication as a water-supply paper. Preparation of the final report on the Roswell artesian basin was continued by Mr. Nye. An intensive investigation of the ground-water supply of the Mimbres Valley was undertaken by W. N. White. A more detailed study of the project for raising the Avalon dam of the Carlsbad irrigation project was undertaken by Mr. Bryan. Mr. Bryan also made a brief study of the feasibility of developing a water supply for irrigation from artesian wells at Tesuque Pueblo, and prepared a report thereon for the Indian Service.

North Dakota.—An investigation of the available sources of water supply at the Standing Rock Indian Agency and School, at Fort Yates, N. Dak., was made by Prof. H. E. Simpson, and a report thereon was submitted to the Indian Service. A. G. Fiedler cooperated in the educational work of the State well drillers' association.

Oregon.—Arrangements were made with the Director of the Oregon Agricultural Experiment Station for cooperation in the investigation of the ground-water resources of the State. An investigation of the ground water available for irrigation in the Willamette Valley was undertaken by A. M. Piper, who also made brief examinations of ground-water conditions in Baker and Harney Valleys and prepared a report on Baker Valley which was transmitted to the Oregon Agricultural Experiment Station. A report on the water-power resources of the Umpqua River and tributaries, by B. E. Jones and H. T. Stearns, was prepared and is in press as Water-Supply Paper 638-F.

Pennsylvania.—The systematic survey of the ground-water resources of Pennsylvania was continued in cooperation with the State Topographic and Geologic Survey. A report by A. M. Piper on six counties in the southwestern part of the State, including the industrial district of Pittsburgh, was transmitted for publication by the State. A similar report by G. M. Hall on fifteen counties in the southeastern part of the State, including the industrial district of Philadelphia, was practically completed. Progress was made by R. M. Leggett on a survey of fourteen counties in the northwestern part of the State.

South Carolina.—Work was continued by C. W. Cooke, of the geologic branch, on the ground-water conditions of the Coastal Plain of South Carolina.

Tennessee.—Work was continued on the systematic survey of the ground-water resources of Tennessee in cooperation with the State geologist. A. M. Piper prepared a report on the springs in 12 counties in north-central Tennessee, which was released in manuscript form. He also made progress on his final report on this area. Eleven counties in the southwestern part of the State were surveyed by F. G. Wells, who gave special attention to the conditions at Memphis. Reports were prepared on the counties covered, and also a special report on the water supply of Memphis. Field work was started in the northwestern part of the State.

Texas.—Progress was made by S. S. Nye on a report on the ground water in 12 counties in the Nueces area of the Texas Coastal Plain. An investigation of the Red Bluff reservoir site on the Pecos River was undertaken by Kirk Bryan.

Utah.—The report on the ground-water supply in the Escalante Valley, Utah, by W. N. White, was nearly completed. Some work was done by Ralf

R. Woolley in revising his report on Green River and its utilization, which is in press as Water-Supply Paper 618. Examinations were made of the power value of lands in the Provo and Sevier River Basins and along Big Brush and Little Brush Creeks. Engineering advice and assistance were given to the Department of Justice in connection with a suit of the United States against the State of Utah involving the Colorado, Green, and San Juan Rivers.

Virginia.—Investigation of the thermal and cold springs of Virginia was continued in cooperation with the State Commission on Conservation and Development. A report was practically completed for publication by the State, with descriptions of 566 springs and partial analyses of 425. Water-stage recorders were operated on the ebbing and flowing spring near Broadway and on the observation well in Arlington County. In cooperation with the State Commission on Conservation and Development a survey of the chemical character of surface water of the State was started April 1, 1929. Daily samples will be collected for a year at 16 gaging stations. Analyses will be made of 10-day composites.

Washington.—Field work and the preparation of reports have been continued to the end of the year on river surveys and power investigations of streams draining the Olympic Range.

Wisconsin.—A. G. Fiedler cooperated in the educational work of the State well drillers' association.

Wyoming.—An ebbing and flowing spring near Afton, Wyo., was examined by O. E. Meinzer and H. T. Stearns, and a water-stage recorder was installed over it.

CONSERVATION BRANCH

HERMAN STABLER, *Chief*

ORGANIZATION AND PERSONNEL

The work of the conservation branch, comprising the classification of public lands with respect to mineral, water-power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands increased materially during the fiscal year 1929. It was directed through four administrative divisions, as follows:

Mineral-classification division, J. D. Northrop, geologist, in charge.

Power division, B. E. Jones, hydraulic engineer, in charge.

Agricultural division, J. F. Deeds, hydraulic engineer, in charge.

Mineral-leasing division, H. I. Smith, chief mining supervisor, in charge.

Personnel changes during the fiscal year include 15 separations (9 resignations, 2 deaths, and 4 transfers) and 17 additions. On June 30, 1929, the personnel of the branch, both office and field, numbered 141, consisting of 5 geologists, 8 hydraulic engineers, 9 mining engineers, 40 petroleum engineers, 8 agricultural classifiers, 1 chemist, 1 attorney, 15 accountants and draftsmen, and 54 clerical employees.

FUNDS

The funds appropriated or transferred for the work of the conservation branch in the fiscal year were as follows:

Classification of lands.....	\$191,500
Supervision of leasing operations, public lands.....	246,000
Supervision of leasing operations, Indian lands.....	70,000
Supervision of naval-reserve operations.....	43,000
Plugging abandoned wells.....	40,000
Federal Power Commission.....	4,000

594,500

Diminished by the special appropriation for plugging abandoned wells, this aggregate is \$5,292, or about 1 per cent, greater than the

corresponding total in 1928. Diminished further by \$32,500 appropriated for salary increases required by the act of May 28, 1928 (45 Stat. 776), this aggregate is \$27,792, or 5 per cent, less than in 1928.

CORRESPONDENCE

During the year 29,873 letter requests for information or technical reports were received in the Washington office of the branch, together with 38,025 additional pieces of miscellaneous correspondence for filing or for transmission to the appropriate field office. Within the same period 24,168 letters were answered and 23,346 additional pieces of miscellaneous correspondence were sent out.

SUMMARY OF LAND-CLASSIFICATION CASES

The activities of the conservation branch with respect to land classification include the preparation of reports in response to requests for data or action on specific cases, the preparation of orders of withdrawal and restoration of lands not involved in specific requests, and the promulgation of broad areal classifications. The following table summarizes activity with respect to requests for data or action on specific cases. The terms "gain" and "loss" signify, respectively, decrease and increase in the number of cases pending. In consequence of strenuous effort and the voluntary overtime work of an efficient personnel the number of cases pending was less by 1,137, or 25 per cent, at the end of the year than at its beginning.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1929						Record since receipt of first case	
	Pending July 1, 1928	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1929	Gain or loss during fiscal year	Received	Acted on
General Land Office requests:								
General.....	344	922	1,266	966	300	+44		
Time extensions.....	41	636	677	671	6	+35	2,313	2,397
Oil development.....	1,607	3,253	4,860	4,843	17	+1,590	16,111	16,094
Applications for classification as to mineral:								
General.....	1	0	1	1	0	+1	10	10
Coal.....	3	5	8	5	3		782	779
Oil.....	98	632	730	474	256	-158	7,338	7,082
Phosphate.....	0	1	1	1	0		38	36
Applications for mineral permits.....	383	3,748	4,131	4,093	38	+345	52,505	52,467
Applications for mineral leases.....	12	102	114	102	12		1,332	1,320
Applications for patent, potassium.....	1	0	1	1	0	+1	124	124
Federal Power Commission cases:								
Preliminary permits.....	10	9	19	8	11	-1	78	67
Licenses.....	0	1	1	1	0		25	25
Determinations under sec. 24.....	8	29	37	35	2	+6	227	225
Applications for reclassification as to water resources:								
Applications for rights of way.....	18	48	66	43	23	-5	759	736
Irrigation project reports.....	31	155	186	151	35	-4	6,224	6,189
Applications under enlarged-homestead acts.....	4	2	6	6	0	+4	911	911
Applications under stock-raising homestead acts.....	214	397	611	345	266	-52	56,809	56,543
Applications under ground-water reclamation act.....	1,704	4,277	5,981	3,640	2,341	-637	126,217	123,876
Indian Office requests for information.....	8	57	65	26	39	-31	935	896
Cases in national forests.....	0	6	6	6	0		9,511	9,511
	1	11	12	10	2	-1	335	333
	4,488	14,291	18,779	15,428	3,351	+1,137		

SUMMARY OF FIELD OPERATIONS BY STATES

Alaska.—Expended \$10,000 through the Alaskan branch for supervision of 9 leases, 3 licenses, and 13 prospecting permits for coal and 1,025 prospecting permits for oil and gas. Coal produced, 107,971.62 tons; accrued rent and royalty, 13,162.60.

Alabama.—Investigated the status of oil and gas prospecting operations throughout the State. Supervised 1 coal lease and 2 oil and gas prospecting permits. Coal produced, 109,832 tons; accrued rent and royalty, \$10,983.20.

Arizona.—Examined 61 tracts for agricultural classification. Supervised 5 coal prospecting permits, 3 sodium permits, 6 potassium permits, and 439 oil and gas permits involving public land. Investigated and reported on the value of 2 iron-ore deposits, 7 radium-ore leases, and 4 coal mines involving lands in 5 Indian reservations.

Arkansas.—Supervised 2 prospecting permits for coal and 15 for oil and gas.

California.—Examined 83 tracts for agricultural classification. Investigated the oil-shale resources of 1 tract in Santa Barbara County and the sodium resources of parts of 2 townships in southeastern Kern County. Investigated the power resources of the Cow Creek Basin, in Shasta County. Supervised on public land 130 leases and 1,301 prospecting permits for oil and gas, 4 leases for potassium, 6 prospecting permits for coal, 5 for sodium, and 1 for potassium. Oil produced, 5,790,220 barrels; natural gas, 1,208,043,000 cubic feet; natural-gas gasoline, 8,199,734 gallons; coal, 36 tons; sodium borate, 7,154.47 tons; sodium carbonate, 15,752 tons. Total rent and royalty accrued, \$677,743.16. Supervised on naval petroleum reserves 27 leases for oil and gas and completed a detailed investigation of subsurface conditions in Reserve No. 1 (Elk Hills). Oil produced, 8,116,636 barrels; natural gas, 7,711,858,000 cubic feet; natural-gas gasoline, 24,908,263 gallons. Total rent and royalty accrued, \$1,817,464.45.

Colorado.—Examined 119 tracts for agricultural classification and made regional studies of agricultural utility precedent to areal classification in the western part of the State. Examined 1 tract in Jackson County and 2 tracts in Grand County for oil and gas classification and 1 tract in Las Animas County for coal classification. Examined and mapped geologic structure in the Garcia field, Las Animas County, and in the Skull Creek district, Routt County. Supervised on public land 12 leases and 1,749 prospecting permits for oil and gas, 77 leases, 5 licenses, and 36 prospecting permits for coal, and 1 prospecting permit for potassium. Oil produced, 962,170 barrels; natural gas, 64,360,000 cubic feet; natural-gas gasoline, 73,522 gallons; coal, 490,446.22 tons. Total rent and royalty accrued, \$106,832.87. Supervised on tribal lands of the Ute Indians 7 leases for oil and gas, and inspected for the Indian Service 1 coal mine on the Southern Ute Reservation.

Idaho.—Examined 68 tracts for agricultural classification. Supervised 269 oil and gas prospecting permits, 9 coal permits, 2 sodium permits, and 2 phosphate leases. Coal produced, 466.65 tons; phosphate rock, 22,612 tons. Total rent and royalty accrued, \$2,385.14.

Kansas.—Supervised 1 prospecting permit for oil and gas.

Louisiana.—Investigated the status of oil and gas prospecting and development throughout the State. Supervised 10 leases and 21 prospecting permits for oil and gas. Oil produced, 7,823.12 barrels; natural gas, 759,719,000 cubic feet; natural-gas gasoline, 54,248.60 gallons. Total rent and royalty accrued, \$3,874.99.

Michigan.—Supervised 1 prospecting permit for oil and gas.

Mississippi.—Investigated the status of oil and gas prospecting throughout the State.

Montana.—Examined 88 tracts for agricultural classification. Began a broad areal investigation of the stratigraphy and structure of parts of Toole, Teton, Chouteau, and Cascade Counties. Continued through the geologic branch detailed examinations in McCone, Richland, Dawson, Rosebud, Custer, and Powder River Counties for coal classification. Supervised on public land 58 leases and 1,387 prospecting permits for oil and gas; 50 leases, 10 licenses, and 12 prospecting permits for coal. Oil produced, 617,051 barrels; natural gas, 1,082,999,000 cubic feet; coal, 299,813.84 tons. Total rent and royalty accrued, \$110,554.70. Supervised on Indian land 117 leases for oil and gas.

Nebraska.—Examined 3 tracts for agricultural classification and made regional investigations in the western part of the State to provide basis for broad areal classification as to agricultural utility. Supervised 3 prospecting permits for oil and gas.

Nevada.—Examined 27 tracts for agricultural classification and made regional investigations of agricultural utility precedent to grazing classification in the northeastern part of the State. Supervised 219 prospecting permits for oil and gas, 5 prospecting permits for coal, 1 lease and 6 prospecting permits for sodium, and 1 lease for phosphate. Sodium sulphate produced, 674.43 tons; phosphate rock, 45.45 tons. Total rent and royalty accrued, \$1,480.

New Mexico.—Examined 10 tracts for agricultural classification. Continued through the geologic branch detailed examinations in McKinley and Sandoval Counties for coal classification. Supervised on public land 8 leases and 3,601 prospecting permits for oil and gas, 16 leases and 64 prospecting permits for coal, 81 prospecting permits for potassium, and 5 prospecting permits for sodium. Oil produced, 158,202 barrels; natural gas, 253,924,000 cubic feet; natural-gas gasoline, 3,792 gallons; coal, 84,441.64 tons. Total rent and royalty accrued, \$50,978.45. Supervised on Indian land 57 oil and gas leases and made technical investigation and report on 1 coal-mining operation in each of the Northern Navajo, Eastern Navajo, and Zuni Reservations.

North Dakota.—Examined 7 tracts for agricultural classification. Supervised 51 leases, 2 licenses, and 3 prospecting permits for coal and 26 prospecting permits for oil and gas. Coal produced, 462,285.16 tons. Total rent and royalty accrued, \$24,763.89.

Oklahoma.—Continued in cooperation with the Oklahoma Geological Survey detailed geologic examination of the coal resources of the Stigler-Muskogee district in Haskell and Muskogee Counties, begun in 1927. Supervised on public land 17 leases for oil and gas involving land in the bed of the Red River, Tillman County, and 69 prospecting permits for oil and gas. Oil produced, 465,086.76 barrels; natural-gas gasoline, 1,528,001.92 gallons. Total rent and royalty accrued, \$114,160.27. Supervised on Indian lands 10,531 leases for oil and gas involving 920,608 acres, 5,651 producing wells, and a combined rental and royalty value of \$5,985,882.34; on segregated Choctaw and Chickasaw lands, 68 leases for coal involving 62,129 acres, a production of 560,979 tons of coal, and a royalty value of \$50,934.59, and 1 lease for asphalt; on allotted restricted lands of Cherokee, Choctaw, and Creek Indians, 63 leases for coal involving a production of 80,101 tons and a royalty value of \$11,236.70, 3 leases for volcanic ash, and 1 for lead and zinc involving production with a royalty value of \$447.44; and on restricted Quapaw lands, 50 departmental leases for lead and zinc involving 6,284 acres, a production of 186,423 tons of concentrates, and a royalty value of \$848,219.49.

Oregon.—Examined 42 tracts for agricultural classification. Investigated the coal resources of John Day Valley between Dayville and John Day, Grant County. Investigated the power resources of the Middle Fork of the Willamette, Santiam, Clackamas, Imnaha, and Wenaha Rivers. Supervised 30 prospecting permits for oil and gas, 2 leases and 3 prospecting permits for coal, 1 lease for oil shale, and 1 prospecting permit for potassium. Coal produced, 3,234.47 tons. Accrued rent and royalty, \$1,187.10.

South Dakota.—Examined 9 tracts for agricultural classification. Supervised 46 prospecting permits for oil and gas and 1 lease for coal. Coal produced, 342.45 tons; accrued rent and royalty, \$80.

Utah.—Examined 113 tracts for agricultural classification. Examined parts of 2 townships in Cache County for phosphate classification and 1 tract in the Marysvale district for potash. Continued through the geologic branch investigations of the areal geology and structure of southern San Juan County and of the coal resources of eastern San Pete County. Investigated the physical characteristics and power resources of parts of the Green and Colorado Rivers. Published and distributed a map showing coal mines and coal occurrence in parts of Carbon and Emery Counties. Supervised on public land 6 leases and 1,913 prospecting permits for oil and gas; 43 leases, 1 license, and 28 prospecting permits for coal; 11 prospecting permits for potassium; and 3 prospecting permits for sodium. Oil produced, 2,953 barrels; natural gas, 1,004,659,000 cubic feet; coal, 580,100.78 tons. Total rent and royalty accrued, \$112,271.96. Supervised 1 lease for oil and gas involving land in the Navajo Indian Reservation.

Washington.—Examined 3 tracts for agricultural classification. Investigated power resources of the Hoh, Bogachiel, Queets, Nespelem, and Sanpoll Rivers. Supervised 28 prospecting permits for oil and gas and 17 for coal.

Wyoming.—Examined 156 tracts for agricultural classification and made regional investigations of agricultural utility precedent to areal classification

in the southwestern part of the State. Mapped the areal and structural geology of the Big Sand Draw gas field, Fremont County, and published a structure-contour map of the field. Investigated structural conditions affecting one tract in Niobrara County and one in Weston County. Collected representative samples of shale formations in Wyoming for ceramic experimentation. Remapped basal coal from Fort Steele westward and southward to the Colorado boundary to conform with certain township resurveys. Supervised on public lands 329 leases and 3,298 prospecting permits for oil and gas; 35 leases, 2 licenses, and 18 prospecting permits for coal; and 1 prospecting permit each for potassium and sodium. Oil produced, 14,455,335 barrels; natural gas, 18,396,690,000 cubic feet; natural-gas gasoline, 37,460,576 gallons; coal, 1,022,860.90 tons. Total rent and royalty accrued, \$2,862,763.66. Supervised 74 leases for oil and gas involving tribal and allotted lands of the Shoshone Indians. Made periodic inspection and pressure test of wells shut in on Naval Petroleum Reserve No. 3 (Teapot dome).

MINERAL-CLASSIFICATION DIVISION

The work of the mineral-classification division involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, chiefly through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation relative to mineral classifications, orders of withdrawal, modification, and restoration. The results of these field investigations take the form of reports concerning the mineral character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public land, Indian land, and naval oil reserves.

Classification phases of division activity were substantially increased by departmental order 349 on May 14, 1929, requiring a report by the Geological Survey to the General Land Office on the prospective value for oil and gas of public lands involved in certain types of nonmineral entries and filings in Alabama, Kansas, Louisiana, Michigan, Mississippi, Nebraska, and Wyoming and in specified counties of Arkansas, California, Colorado, Florida, Idaho, Michigan, Montana, New Mexico, North Dakota, Oregon, South Dakota, Utah, and Washington, as a basis for the reservation or waiver of the Government's title to deposits of those minerals. To the end of the fiscal year 425 requests for reports of this type had been received.

Little progress was made in 1929 in classifying the vast areas of public land that are still embraced in mineral withdrawals. The results accomplished include, however, net decreases of 57,006 acres in the total area of outstanding coal withdrawals, of 92,140 acres in the total area of outstanding petroleum withdrawals, and of 26,261 acres in the total area of outstanding phosphate reserves.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications, June 30, 1929, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash
	With- drawn	Classified as coal land	With- drawn	Classi- fied as oil land	With- drawn	Classi- fied as oil- shale land	With- drawn	Classi- fied as phos- phate land	With- drawn
Alaska.....		56,993							
Arizona.....	139,415		356						
Arkansas.....		61,160							
California.....	17,603	8,720	1,178,392						90,357
Colorado.....	4,142,233	3,082,272	218,997		64,560	952,239			
Florida.....							67,076	120	
Idaho.....	4,761	4,603					391,532	268,299	
Louisiana.....			466,990	4,233					
Montana.....	7,863,941	8,543,862	1,350,426	67,651			279,944	3,833	
Nevada.....	83,673				123				39,422
New Mexico.....	5,084,069	570,372							9,282,100
North Dakota.....	5,964,364	11,178,286	84,894						
Oregon.....	4,361	18,887							
South Dakota.....		250,093							
Utah.....	3,636,541	1,267,697	1,341,264		91,464	2,708,755	277,344	2,937	
Washington.....	691,801	141,444							
Wyoming.....	2,260,604	6,740,594	541,777		460,103	989,149	25,293		
	29,883,366	31,944,983	5,183,096	71,884	156,147	4,116,097	2,005,045	300,482	9,411,939

* Includes 3,151 acres of coal land reserved for use of the United States (coal reserve No. 1).

* Includes 2,078 acres of coal land reserved for use of the United States (coal reserve No. 2).

The functions of this division in connection with administration of the mineral leasing laws, fully described in earlier reports, continued unchanged with respect to coal, phosphate, oil-shale, potassium, and sodium filings throughout the year and with respect to oil and gas filings until March 12, 1929, when a change of administrative policy necessitated material change in their nature. Subsequent to that date they were generally restricted, as far as oil and gas cases, outside Alaska, were concerned, to the preparation of technical reports on the status of drilling operations initiated or completed on permit holdings, or on the geologic structure affecting them, that had been held for cancellation or were involved in pending applications for extension of time, reinstatement, or assignment, and to the appraisal of geologic showings submitted in support of such applications. To July 1, 1929, a total of 543 reports of this type had been submitted to the "departmental committee to pass on claims in connection with oil and gas permits" pursuant to departmental order 337, of March 16, 1929, outlining procedure under the Federal oil-conservation policy announced by President Hoover March 12, 1929. Prior to that date 4,450 reports on drilling status were rendered to the General Land Office in furtherance of its campaign begun in 1928 to cancel oil and gas prospecting permits the terms of which had had no bona fide compliance.

The following table summarizes the year's work to the extent that it involved technical reports on original applications for permit or lease rights on public lands. Except for a few cases involving land in Alaska, the recorded action on oil and gas prospecting permit applications antedated March 12, 1929.

*Applications received, acted on, and pending under the mineral leasing acts,
fiscal year 1929*

Mineral	Prospecting permits			Leases		
	Received	Acted on	Pending	Received	Acted on	Pending
Oil and gas.....	3,945	3,932	13			
Coal.....	116	104	12	99	89	10
Phosphate.....				2	1	1
Sodium.....	35	30	5	7	6	1
Potassium.....	35	27	8	5	5	
Oil shale.....				1	1	
	4,131	4,063	38	114	102	12

In accordance with the duty delegated to the Geological Survey by section 2 of the departmental regulations pertaining to oil and gas prospecting permits and leases, revisions of the definitions of the "known geological structure" of the following producing fields were prepared and promulgated during the year:

Middle Red River, Okla.; 418 acres (additional 196 acres); promulgated October 18, 1928.

Big Sand Draw, Wyo.; 4,830 acres (diminished 2,563 acres); promulgated August 24, 1928.

The net area included in outstanding definitions of the "known geological structure" of producing oil and gas fields on June 30, 1929, was 515,378 acres in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Geologic field work required in the solution of the problems of the division is performed in part by summer detail of Washington employees, in part by a division geologist with permanent headquarters in Denver, Colo., and in part by the geologic branch at the expense of the conservation branch. The work accomplished in 1929 is included in the branch summary of field operations by States beginning on page 61.

POWER DIVISION

The work of the power division consists primarily in obtaining and making available for use in the administration of the public-land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public-land laws. An endeavor is made to determine the proper administrative action by which the possibility of power development may be preserved with minimum interference with agricultural, transportation, or other interests. In the course of this work a review of all power reserves is carried on in order that all land having primary value for the development of power, and only such land, shall be reserved for that purpose. The extent of this task is indicated by the fact that areas aggregating more than 6,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches of the Geological Survey. The field projects undertaken during the year to obtain information for power classification, including plan and profile surveys, power-site and reservoir-site investigations, and geologic studies of dam sites, are included in the branch summary of field operations by States (pp. 61-63).

The information obtained in the field is indexed and incorporated in an inventory of water resources which, when complete, will enable the Geological Survey to give competent advice on short notice as to the manner in which each tract of public land having value for power can best be used in connection with the development of water power and as to the relation of such use to other possible uses of the tract. Copies of many of the reports on the power possibilities of the streams examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press.

The work of the division is briefly summarized in the accompanying tables showing power-site reserves and outstanding water-resources withdrawals and classifications and in the general summary.

Pursuant to instructions of the Secretary of the Interior dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted by the Secretary since January 1, 1913, were called upon for detailed reports of the operation or development of their power systems during the calendar year 1928. The total installation of the reporting companies is 3,244,000 kilowatts, of which 2,415,000 kilowatts is installed at hydraulic plants. The total energy generated was 8,987,000,000 kilowatt-hours, of which more than 8,051,000,000 kilowatt-hours was generated by water power. The energy generated by steam has increased 366,000,000 kilowatt-hours, and that generated by water power 505,000,000 kilowatt-hours, making a total increase of 871,000,000 kilowatt-hours.

Power output of permittees and grantees, 1916-1928

Calendar year	Kilowatt-hours	Increase or decrease		Calendar year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1916.....	1,200,000,000			1923.....	5,910,000,000	+963,000,000	+19
1917.....	2,000,000,000	+800,000,000	+67	1924.....	6,103,000,000	+164,000,000	+3
1918.....	3,200,000,000	+1,200,000,000	+60	1925.....	6,930,000,000	+830,000,000	+14
1919.....	3,100,000,000	-100,000,000	-3	1926.....	7,800,000,000	+870,000,000	+13
1920.....	4,300,000,000	+1,100,000,000	+35	1927.....	8,116,000,000	+316,000,000	+4
1921.....	3,725,000,000	-475,000,000	-11	1928.....	8,987,000,000	+871,000,000	+11
1922.....	4,947,000,000	+1,222,000,000	+33				

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1928	Eliminated prior to July 1, 1928	Reserves outstand- ing prior to July 1, 1928	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstand- ing June 30, 1929
Alabama	2,377		2,377			2,377
Alaska	247,066	520	246,546	35,861		282,407
Arizona	1,282,976	124,012	1,158,964	13,380	15	1,172,329
Arkansas	29,671	360	29,311			29,311
California	1,368,036	30,243	1,337,793	68,839	3,037	1,403,595
Colorado	537,520	77,020	460,500	20,100	5,210	475,390
Florida	1,131		1,131			1,131
Idaho	605,642	191,534	414,108	5,061		419,169
Michigan	1,240		1,240			1,240
Minnesota	19,062	532	18,530			18,530
Mississippi	3		3			3
Montana	304,489	96,379	208,110	1,378	280	209,206
Nebraska	761		761			761
Nevada	301,196	480	300,716	58,019		358,735
New Mexico	270,878	10,511	260,367	49	732	259,684
Oregon	799,204	123,963	645,241	16,063	19,521	641,783
South Dakota	636		636			636
Utah	771,933	126,518	645,415	7,436	3,720	649,131
Washington	398,015	53,835	344,180	51,849	52	395,977
Wisconsin	1,866	226	1,640	40		1,680
Wyoming	232,477	76,284	156,193	300		156,493
	7,146,179	912,417	6,233,762	278,375	32,567	6,479,570

Summary of outstanding water-resources withdrawals and classifications, June 30, 1929, in acres

State	Power reserves					Reservoir with- drawals	Public water reserves
	Withdraw- als	Classifica- tions	Designa- tions *	Miscella- neous	Total		
Alabama	120	1,735		522	2,377		
Alaska	93,415	105,425		83,567	282,407		
Arizona	386,244	50,082	528,237	207,766	1,172,329	23,040	19,425
Arkansas	21,994	1,500		5,727	29,311		
California	285,056	350,219		759,321	1,403,595	1,160	199,506
Colorado	225,463	193,989		55,938	475,390	1,728	7,540
Florida				1,131	1,131		
Idaho	206,272	195,364		17,533	419,169		14,345
Michigan	1,240				1,240		
Minnesota	12,309			6,221	18,530		
Mississippi				3	3		
Montana	130,337	53,862		25,009	209,206	9,080	9,017
Nebraska	761				761		
Nevada	27,492	85,866		245,377	358,735		12,101
New Mexico	116,474	49	143,161		259,684		11,001
North Dakota						1,569	
Oregon	355,272	194,280	15,250	76,981	641,783	10,619	25,941
South Dakota				636	636		240
Utah	438,655	176,204		34,272	649,131	80	35,970
Washington	97,084	226,775		72,168	395,977	35,943	920
Wisconsin				1,680	1,680		
Wyoming	79,953	35,407		41,133	156,493	1,714	82,425
	2,478,090	1,679,847	686,048	1,634,985	6,479,570	84,933	418,431

* Designated and not otherwise withdrawn.

AGRICULTURAL DIVISION

The functions of the agricultural division consist of the classification of lands under the enlarged-homestead law as nonirrigable; the classification of lands under the Nevada ground water reclamation law as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public-land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; and the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family.

Applications for classification are disposed of in accordance with the results of field examinations by members of the division and with information obtained from other sources. Applications in some regions lead to the planning and execution of broad field studies that result in the classification of large areas and provide in advance the basis for appropriate action on new applications.

The number of cases received and acted on during the fiscal year by the agricultural division is shown in the general summary of cases (p. 60). It increased about 22 per cent above the number received in 1928 and resulted in an arrearage 37 per cent greater at the end of 1929 than at the end of 1928.

In the field broad areal studies were continued in the Colorado Basin region in northwestern Colorado and southwestern Wyoming.

The series of five maps showing the agricultural utility of the central Great Plains was completed and published, together with brief texts discussing the agricultural characteristics of three of the areas. Text for the other two maps was partly completed. Revision of a text for the series of eight similar maps relating to the northern Great Plains prepared in cooperation with the Department of Agriculture was also completed.

During the fiscal year the area designated under the Nevada ground water reclamation act as a result of the work of the division was increased 24,080 acres, to a total of 1,643,295 acres. Outstanding withdrawals, aggregating 11,530 acres, under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

Summary of enlarged-homestead designations, in acres

as classified as arid and nonirrigable, residence by entryman required: Act of Feb. 19, 1909 (35 Stat. 1), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 132) applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat. 953), applicable to Kansas; act of Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota. Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entryman not required: Act of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho]

State	Designations prior to July 1, 1928	Cancellations prior to July 1, 1928	Designations outstanding prior to July 1, 1928	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1929
Idaho	31,502,584	5,870,874	25,631,710	30,120	13,440	25,648,390
Montana	13,333,226	240,453	13,092,773	48,207		13,140,980
Nebraska	33,810,627	195,808	33,615,119	162,165	920	33,776,364
Total	13,754,190	461,365	13,292,825	2,126		13,294,951
Nonresidence	573,227	4,233	568,994			568,994
Arizona	651,364		651,364			651,364
California	53,485,650	245,728	53,239,922	2,011		53,241,933
Colorado	50,168,165	3,580,717	46,587,448	50,379		46,637,827
Idaho	43,837,357	227,732	43,609,625	11,650	160	43,621,115
New Mexico	12,280,704	3,848	12,276,856			12,276,856
North Dakota	21,282,311	989,902	20,292,409			20,292,409
South Dakota	16,340,761	348,170	15,992,591	2,080		15,994,671
Total	11,654,776	701,484	10,953,292	93,294	344,833	10,701,753
Nonresidence	1,650,911	81,880	1,569,031		344,833	1,224,198
Washington	6,660,452	251,842	6,408,610			6,408,610
Wyoming	29,677,292	162,043	29,515,249	99,814		29,615,063
	338,439,459	13,279,666	325,159,793	501,846	359,353	325,302,296

Summary of stock-raising homestead designations, in acres

as classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of h character that 640 acres is reasonably required for the support of a family, act of Dec. 29, 1916 (39 Stat. 862)]

State	Designations prior to July 1, 1928	Cancellations prior to July 1, 1928	Designations outstanding prior to July 1, 1928	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1929
Idaho	14,056,666	887,680	13,169,086	98,207		13,267,293
Montana	1,120		1,120			1,120
Nebraska	7,065,904	3,400	7,062,504	64,471		7,126,975
Nebraska	8,647,578	18,920	8,628,658	224,484	920	8,852,222
Idaho	480					
Arizona	5,545,291	1,854	5,543,437	51,719		5,595,156
California	115,139		115,139	640		115,779
Idaho	3,491		3,491			3,491
Montana	15,487,123	17,081	15,470,042	127,252		15,597,294
Nebraska	202,184		202,184	3,977		206,161
Idaho	586,089	3,120	582,969	10,537		593,506
New Mexico	31,363,953	636	31,363,317	144,213		31,507,530
North Dakota	383,700		383,700			383,700
Idaho	83,610		83,610	1,308		84,918
Montana	6,355,378	3,128	6,352,250	29,098		6,381,318
South Dakota	6,510,043	550	6,509,493	9,498		6,518,996
Idaho	1,796,149	7,800	1,788,349	142,173		1,930,522
Washington	694,686	1,174	693,512			693,512
Wyoming	20,278,111	6,373	20,271,738	236,130	800	20,507,068
	120,076,700	952,096	119,124,604	1,143,677	1,720	120,266,561

by blanket order of withdrawal creating public water reserve No. 107, which received Executive approval April 17, 1926, every smallest legal subdivision of the public-land surveys which is vacant unappropriated public land and contains a spring or water hole and land within a quarter of a mile of every spring or water hole situated on unsurveyed public land was reserved for public use and aid of pending legislation. This order obviated the necessity for future withdrawals of specific tracts containing springs or water

holes valuable for stock watering but requires a determination by the division with respect to all entries of public land, whether or not any of the subdivisions involved are in fact affected by it. On the basis of such determination orders of interpretation are issued from time to time listing by legal subdivisions of the public-land survey any tracts found to contain a water supply affected by the order. New withdrawals of this type are made to reserve lands along streams and are also made from time to time for special public purposes. The extent of outstanding reserves of this type and of current action affecting them is shown in the following table:

Public water reserves, in acres

[Includes areas withdrawn under the act of June 25, 1910 (41 Stat. 1363), as amended by the act of Aug. 24, 1912 (37 Stat. 497), and reserved for public use of springs or water holes in accordance with the provisions of sec. 10 of the act of Dec. 29, 1916 (39 Stat. 862), or for watershed protection, drainage reservoirs, or other similar miscellaneous public purposes involving water conservation]

State	Reserved prior to July 1, 1928	Eliminated prior to July 1, 1928	Reserves outstanding July 1, 1928	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1928
Arizona.....	21, 782	1, 632	20, 150		725	19, 425
California.....	205, 924	7, 138	198, 786	720		199, 506
Colorado.....	5, 220	360	4, 860	2, 680		7, 540
Idaho.....	14, 315	418	13, 905	440		14, 345
Montana.....	10, 009	1, 162	8, 847	240	80	9, 017
Nevada.....	14, 421	3, 250	11, 176	925		12, 101
New Mexico.....	10, 411	620	9, 881	1, 120		11, 001
Oregon.....	22, 541	1, 288	21, 251	4, 680		25, 931
South Dakota.....	240		240			240
Utah.....	41, 626	7, 596	33, 930	2, 040		35, 970
Washington.....	920		920			920
Wyoming.....	92, 845	13, 420	79, 425	3, 640	640	82, 425
	440, 187	36, 766	403, 391	16, 485	1, 445	418, 431

MINERAL-LEASING DIVISION

The work of the mineral-leasing division is supervisory (both inspectional and regulatory) with respect to operations for the discovery and development of petroleum, natural gas, oil shale, coal, phosphate, sodium, potassium, and sulphur on public lands; of petroleum and natural gas on naval petroleum reserves; and of coal, oil and gas, zinc, iron, silver-lead, and radium ores, asbestos, asphalt, and volcanic ash on Indian lands. This work is carried on with a minimum of administrative supervision from Washington through district offices and suboffices at or near the primary centers of mining or drilling activities, under the direction of responsible engineers who have full authority to represent the Government within their jurisdiction and to enforce compliance with the law and regulations under which operations are conducted.

ACTIVITIES ON THE PUBLIC DOMAIN

Supervisory work on lands containing publicly owned mineral deposits was increased during the fiscal year by the issuance of leases, licenses, and prospecting permits as follows:

	Number	Acres		Number	Acres
Leases:			Permits:		
Oil and gas.....	62	26, 595. 77	Oil and gas.....	2, 416	4, 093, 743. 29
Coal.....	39	6, 511. 04	Coal.....	83	91, 060. 46
Licenses:			Potassium.....	32	63, 905. 63
Coal.....	13	426. 29	Sodium.....	8	13, 094. 59

uring the same period supervisory work was decreased by the ellation of 17 coal leases, 4 coal-prospecting permits, 26 potas- i-prospecting permits, 1 sodium-prospecting permit, 8 oil and leases, and 8,700 oil and gas prospecting permits—a total of 8,756 ellations, compared with the total of 7,827 for the fiscal year 1928. he following table shows the total number of leases, licenses, and nits involving public land in effect at the end of the fiscal year:

ral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey June 30, 1929

State	Coal						Oil and gas	
	Leases		Permits		Licenses		Leases (number)	Permits (number)
	Number	Acres	Number	Acres	Number	Acres		
na.	9	11,307.28	13	22,548.84	3	30.00		1,025
a.	1	1,840.00						2
as.			5	11,520.00				436
nia.			2	2,199.88				15
io.	77	12,252.60	6	6,511.17			*157	1,301
			36	22,542.90	5	200.00	12	1,749
			9	11,697.17				299
ma.								1
na.	50	6,168.17	12	7,840.00	10	396.29	10	*21
ka.							58	1,387
l.			5	7,821.88				3
lexico.	16	10,310.28	64	101,121.53			8	219
Dakota.	51	6,176.86	3	360.46	2	80.00		3,601
ma.								26
d River.							17	60
Dakota.	2	1,895.24	3	760.00				9
	1	79.04						30
ngton.	43	33,281.47	28	27,594.47	1	80.00	6	46
ing.			17	13,742.33				1,913
	35	14,718.98	18	17,694.30	2	80.00	329	28
								3,298
	285	98,029.92	221	253,954.93	23	866.29	597	15,442

State	Sodium				Potash			
	Leases		Permits		Leases		Permits	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres
l.			3	5,200.00			*1	2,400.00
nia.			5	5,995.96	4	7,783.80	5	9,040.00
io.							*1	2,559.58
							1	2,538.67
l.	1	1,440.00	2	3,254.11				
lexico.			6	11,075.63			*7	16,400.00
			5	12,490.00			74	169,704.30
							1	2,560.00
							*9	16,518.68
			3	3,840.00			2	3,361.33
ing.			1	1,245.00			1	1,760.00
	1	1,440.00	25	43,090.70	4	7,783.80	102	226,842.56

cludes 15 leases on naval petroleum reserves 1 and 2 under the act of Feb. 25, 1920, and 12 on naval um reserves 1 and 2 under the act of June 4, 1920.

and gas permits in Louisiana include the right to lease sulphur deposits discovered while prospecting nd gas.

ler the act of Oct. 2, 1917.

Idaho, 2 phosphate leases, 1,700 acres; Nevada, 1 phosphate lease, 160 acres; Oregon, 1 oil-shale lease, res. Total leases, 891; licenses, 23; permits 15,790; grand total, 16,704.

Since October 20, 1914, the date of approval of the Alaska coal-land leasing act (38 Stat. 741), the Secretary of the Interior has issued a total of 653 leases and 34,672 prospecting permits for oil and gas; 357 leases, 149 licenses, and 1,102 prospecting permits for coal; 18 leases and 680 prospecting permits for potassium; 1 lease and 88 prospecting permits for sodium; 2 leases for oil shale; and 3 leases for phosphate.

PRODUCTION

Compared with 1928, mineral production from public lands in the fiscal year 1929 increased as follows: Coal, 161,583 tons, or 5 per cent; natural gas, 3,848,368,110 cubic feet, or 20 per cent; natural-gas gasoline, 7,621,581 gallons, or 19 per cent; sodium minerals, 7,453 tons, or 46 per cent. In the same period decrease was recorded in the production of petroleum to the extent of 911,707 barrels, or 4 per cent; and of phosphate rock to the extent of 1,668 tons, or 8 per cent. Prospecting for potassium was continued in Eddy County, N. Mex., where 9 prospect holes were drilled by permittees to an aggregate depth of 12,470 feet. No potassium salts were produced from public land in 1929.

Important sources of oil and gas production discovered or actively developed during the year in areas containing relatively large holdings of public land include the Kettleman Hills field, Kings County, Calif.; the Jal district, Lea County, N. Mex.; and the Hiaawatha district, Sweetwater County, Wyo. Phosphate production was also begun in Nevada from a cave deposit of guano in White Pine County.

Statistics of mineral production under Federal leases, licenses, and prospecting permits are summarized in the following tables:

Petroleum, natural gas, and natural-gas gasoline produced from public lands

Total

Fiscal year	Petroleum	Natural gas	Gasoline
	<i>Barrels</i>	<i>M cubic feet</i>	<i>Gallons</i>
1921-1925.....	118,333,954.01	60,298,796.00	63,997,713.97
1926.....	29,712,876.16	18,535,880.50	35,910,791.54
1927.....	25,648,101.43	17,723,410.03	40,104,404.57
1928.....	23,370,549.38	18,922,026.00	39,698,292.82
1929.....	22,458,842.62	22,770,394.11	47,319,674.32
	219,524,323.60	138,250,506.64	227,031,062.22

1929, by States

California.....	5,790,220.07	1,208,043.11	8,190,733.80
Colorado.....	962,170.29	64,360.00	73,522.00
Louisiana.....	7,823.92	750,719.00	54,248.00
Montana.....	617,051.45	1,082,999.00	
New Mexico.....	178,202.44	253,924.00	3,792.00
Oklahoma.....	465,086.76		1,528,001.92
Utah.....	2,953.13	1,004,650.00	
Wyoming.....	14,455,334.76	18,396,690.00	37,460,376.00

State details of petroleum produced for previous years are given in the Forty-eighth Annual Report.

Coal produced from leases, licenses, and permits on public lands, in tons, by fiscal years

State	1912-1925	1926	1927	1928	1929	Total
Alaska.....	455,497.43	98,144.74	93,416.14	106,382.66	107,971.62	861,412.59
Alabama.....		10,056.00	22,854.00	43,523.00	109,832.00	186,265.00
California.....			8.00	3.00	36.00	42.00
Colorado.....	2,028,940.29	353,433.61	448,552.09	439,650.40	490,446.22	3,761,022.61
Idaho.....					466.65	466.65
Montana.....	252,973.58	198,602.15	278,896.48	278,886.33	299,813.84	1,309,172.38
Nevada.....				91.15		91.15
New Mexico.....	74,427.26	37,461.86	85,906.31	74,462.82	84,441.64	356,698.89
North Dakota.....	453,695.38	163,533.79	215,540.12	404,456.71	462,285.16	1,699,511.16
Oregon.....	688.97	628.88	423.58	1,280.03	3,234.47	6,255.93
South Dakota.....	1,842.63	1,074.00	531.11	422.68	342.45	4,212.87
Utah.....	487,303.62	172,433.36	282,564.80	432,707.96	580,100.78	1,955,110.52
Washington.....	164,280.43	16,910.29	30,974.32	33,723.99		245,889.03
Wyoming.....	4,465,895.23	962,490.51	1,053,037.36	1,194,657.65	1,022,860.90	8,688,931.65
	8,385,534.82	2,014,769.19	2,512,698.31	3,000,248.38	3,161,831.73	19,075,082.43

Sodium salts produced from public lands, in tons, by fiscal years

State	1921-1925	1926	1927	1928	1929	Total
California.....	3,145.30	430.09	5,911.35	15,377.99	22,906.47	47,771.20
Nevada.....	248.25	233.53	302.53	750.00	674.43	2,208.74
	3,393.55	663.62	6,213.88	16,127.99	23,580.90	49,979.94

Phosphate produced from public lands, in tons, by fiscal years

State	1921-1925	1926	1927	1928	1929	Total
Idaho.....	6,132.44	343.20	23,854.61	23,459.95	21,746.61	75,536.81
Nevada.....					45.45	45.45
	6,132.44	343.20	23,854.61	23,459.95	21,792.06	75,582.26

Productive leases, permits, and licenses, fiscal year 1929

State	Coal		Potash	Sodium	Phos- phate	Oil and gas
	Shipping	Wagon				
Alaska.....	4	1				
Alabama.....	1					
California.....		1	2			69
Colorado.....	15	49				12
Idaho.....	0	3			1	
Louisiana.....						7
Montana.....	2	65				50
Nevada.....				1	1	
New Mexico.....	6	10				28
North Dakota.....	7	56				
Oklahoma.....						17
Oregon.....		2				
South Dakota.....		1				
Utah.....	17	16				8
Washington.....						
Wyoming.....	13	26				304
	65	230	2	1	2	495

ROYALTY, RENT, AND BONUSES

The following tables summarize accrued income from all mineral leases, licenses, and prospecting permits under the various leasing acts applicable to the public lands:

Royalties, rentals, and bonuses accrued from all mineral operations on public lands, by fiscal years

State	1912-1925	1926	1927	1928	1929	Total
Alabama.....	\$86,380.00	\$1,005.60	\$2,285.40	\$4,352.30	\$10,963.20	\$105,006.50
Alaska.....	35,142.42	9,227.63	11,327.50	19,495.19	13,162.60	89,355.24
California.....	4,676,746.55	1,259,912.83	966,228.53	1,356,050.49	677,743.16	8,936,681.56
Colorado.....	216,853.81	124,725.20	115,573.21	102,702.44	106,832.87	666,687.53
Idaho.....	1,111.38	695.00	2,549.41	2,529.85	2,385.14	9,270.78
Louisiana.....	1,509.69	1,670.12	15,963.32	3,829.21	10,723.06	33,724.30
Montana.....	891,278.79	355,254.89	172,765.63	107,964.87	110,554.70	1,637,818.88
Nevada.....	301.07	2,160.00	1,440.00	1,462.79	1,480.00	6,843.86
New Mexico.....	13,883.64	14,578.85	20,894.50	25,331.39	50,978.45	125,566.85
North Dakota.....	20,144.79	12,320.50	15,379.14	30,138.88	24,763.89	111,747.20
Oklahoma.....		46,813.28	182,829.59	147,974.25	114,160.27	490,777.39
Oregon.....	952.15	972.80	1,048.00	948.00	1,187.10	5,108.05
South Dakota.....	399.60	227.34	40.86	43.32	80.00	791.12
Utah.....	138,932.03	87,282.79	71,864.60	79,144.70	112,271.36	489,495.48
Washington.....	22,215.91	1,721.04	3,096.57	3,495.22		30,528.74
Wyoming.....	31,200,133.17	6,862,754.84	4,760,870.88	2,909,905.61	2,862,703.66	48,602,428.16
	37,320,963.90	8,780,022.74	6,344,187.23	4,795,368.51	4,100,069.46	61,340,631.84

Royalty and bonuses accrued from oil and gas operations on public lands

Total

Fiscal year	Royalty			Bonuses	Total
	Petroleum	Natural gas	Gasoline		
1921-1925.....	\$32,938,494.47	\$398,543.30	\$251,197.70	\$2,768,085.14	\$36,356,320.61
1926.....	7,951,663.52	93,508.19	154,265.43	230,503.94	8,449,941.18
1927.....	5,741,485.97	91,790.54	173,172.59	3,980.00	6,010,430.10
1928.....	3,519,810.55	108,570.86	107,070.00	672,500.00	4,407,951.41
1929.....	3,437,477.58	125,013.01	116,254.69	7,138.07	3,685,883.35
	53,588,934.09	817,432.00	801,960.41	3,702,207.15	58,910,533.65

1929, by States

California.....	\$642,073.06	\$6,030.46	\$17,641.31		\$665,744.83
Colorado.....	45,702.15	1,484.14	96.27		47,282.56
Louisiana.....	1,606.07	2,022.43	246.49	\$6,848.07	10,723.06
Montana.....	73,677.27	3,911.40			77,588.67
New Mexico.....	30,022.84	6,943.49	125.54		37,091.87
Oklahoma.....	107,752.03		6,408.24		114,160.27
Utah.....	305.34	6,071.62			6,377.46
Wyoming.....	2,536,338.32	98,549.47	91,736.04	290.00	2,726,914.63

Rent, royalty, and bonuses accrued from mining operations on public lands

	Coal	Sodium	Phosphate	Potash	Bonuses	Total
1929						
Alabama.....	\$10,983.20					\$10,983.20
Alaska.....	13,162.60					13,162.60
California.....	9.00			\$11,989.33		11,998.33
Colorado.....	59,250.31				\$300.00	59,550.31
Idaho.....	116.66		\$2,268.48			2,385.14
Montana.....	32,966.03					32,966.03
Nevada.....		\$1,440.00	40.00			1,480.00
New Mexico.....	13,886.58					13,886.58
North Dakota.....	24,579.89				184.00	24,763.89
Oregon.....	1,187.10					1,187.10
South Dakota.....	80.00					80.00
Utah.....	105,893.90					105,893.90
Wyoming.....	135,849.03					135,849.03
	397,964.30	1,440.00	2,308.48	11,989.33	484.00	414,186.11
SUMMARY						
1912-1925.....	790,408.19	301.07	1,111.38	24,458.65	148,384.00	964,663.29
1926.....	319,626.78	2,160.00	695.00	6,031.78	1,566.00	330,079.56
1927.....	322,308.12	1,440.00	2,549.41	6,217.60	1,237.00	333,752.13
1928.....	372,949.85	1,440.00	2,520.65	9,402.40	1,095.00	387,417.10
1929.....	397,964.30	1,440.00	2,308.48	11,989.33	484.00	414,186.11
	2,203,287.24	6,781.07	9,194.12	58,099.76	152,766.00	2,430,098.19

ACTIVITIES ON NAVAL PETROLEUM RESERVES

On March 17, 1927, by Executive order, the administration of all naval petroleum reserves was vested in the Department of the Navy. Pursuant to a cooperative agreement engineering supervision was continued by the Geological Survey under the direction of the Secretary of the Navy.

Statistics of the production of petroleum, natural gas, and natural-gas gasoline from naval petroleum reserves are summarized as follows:

*Royalty accrued from naval petroleum reserves**By States*

State	Petroleum	Natural gas	Gasoline	Total
California:				
1921-1925.....	\$10,127,293.96	\$287,996.12	\$231,447.70	\$10,646,737.78
1926.....	3,187,461.22	100,089.27	151,506.95	3,439,057.44
1927.....	3,094,331.59	90,475.99	163,760.36	3,348,567.94
1928.....	1,909,711.11	125,866.88	162,834.08	2,198,412.07
1929.....	1,583,072.32	82,685.76	151,706.37	1,817,464.45
	19,901,870.20	687,114.02	861,045.46	21,450,029.68
Wyoming:				
1923-1927.....	763,114.40	44,765.64	7,104.55	814,984.59
1928.....	24,169.70	7,952.86	1,840.70	33,963.32
1929.....				
	787,284.10	52,718.50	8,945.31	848,947.91
Total				
1921-1925.....	\$10,685,660.38	\$398,874.65	\$231,485.45	\$11,316,020.48
1926.....	3,310,658.54	114,247.75	152,480.36	3,577,386.65
1927.....	3,175,882.55	110,204.62	169,643.75	3,455,730.92
1928.....	1,933,880.61	133,819.74	164,674.84	2,232,375.39
1929.....	1,543,072.32	82,685.76	151,700.37	1,817,464.45
	20,649,154.30	739,852.52	809,990.77	22,198,997.59

*Petroleum, natural gas, and gasoline produced from naval reserves***By States**

	Petroleum	Natural gas	Gasoline
	<i>Barrels</i>	<i>M cubic feet</i>	<i>Gallons</i>
California:			
1921-1925.....	37,882,945.09	35,544,349.81	34,508,751.07
1926.....	12,234,702.16	12,917,255.09	19,851,262.68
1927.....	12,368,315.70	12,328,208.69	24,052,402.12
1928.....	9,690,573.93	9,077,966.68	24,797,263.61
1929.....	8,116,635.98	7,711,858.00	24,908,262.82
	80,293,172.86	77,579,638.27	128,117,962.30
Wyoming:			
1923-1925.....	2,523,213.05	950,520.00	7,820.00
1926.....	520,680.00	1,458,032.00	291,552.00
1927.....	357,049.32	1,958,463.00	1,441,036.00
1928.....	149,285.26	795,854.00	743,179.00
	3,550,227.63	5,162,869.00	2,483,896.00
Total			
1921-1925.....	40,406,158.14	36,494,869.81	34,516,580.07
1926.....	12,755,382.16	14,375,287.09	20,143,134.68
1927.....	12,725,365.02	14,286,671.69	25,493,438.12
1928.....	9,839,859.19	9,873,820.68	25,540,442.61
1929.....	8,116,635.98	7,711,858.00	24,908,262.82
	83,843,400.49	82,742,507.27	130,601,858.33

Production from naval petroleum reserve No. 3, in Wyoming, was definitely suspended in January, 1928. Supervision on this reserve for the present is confined to observation of gas pressure and consultation with the Navy Department.

ACTIVITIES ON INDIAN LANDS

On behalf of the Indian Service, the mineral-leasing division exercises technical supervision over all oil and gas operations, except in the Osage Reservation, Okla., and over all mining operations on tribal and allotted Indian lands and on Indian reservations set aside by Executive order. For the performance of these functions field offices are maintained at Muskogee, Okmulgee, Tulsa, Oklahoma City, Shawnee, Miami, and McAlester, Okla.; Farmington, N. Mex.; and Thermopolis, Wyo., and additional service is provided from other field offices of the conservation branch as needed.

The supervision of oil and gas activities in Oklahoma, exclusive of the Osage Reservation, includes 10,531 leases, covering 920,608.25 acres, on which there are 5,651 producing oil and gas wells, summarized by jurisdiction or Indian agencies as follows:

Oil and gas leases in Oklahoma exclusive of the Osage Reservation

Agency	Leases			Wells		Total royalty and rentals
	Non-producing	Pro-ducing	Total	Pro-ducing	Being drilled	
Five Civilized Tribes:						
Cherokee.....		387				
Choctaw.....		62				
Creek.....	7,022	626	8,239	5,416	85	
Chickasaw.....		18				
Seminole.....		124				
	7,022	1,217	8,239	5,416	85	\$5,646,586.53
Kiowa Indian Agency:						
Kiowa.....	162	0	162	0	0	
Comanche.....	309	19	328	23	1	
Apache.....	9	6	15	16	0	
Wichita.....	38	0	38	0	0	
Caddo.....	131	0	131	0	0	
	649	25	674	39	1	150,540.30
Pawnee Indian Agency:						
Ponca.....	195	14	209	56	0	
Otoe.....	232	2	234	2	1	
Tonkawa.....	21	0	21	0	0	
Pawnee.....	201	20	221	56	1	
Kaw.....	49	4	53	33	0	
	698	40	738	149	2	224,580.61
Shawnee Indian Agency:						
Iowa.....	30	0	30	0	0	
Kickapoo.....	84	0	84	0	0	
Pottawatomie.....	67	6	73	23	3	
Sac and Fox.....	176	9	185	24	1	
Shawnee.....	212	0	212	0	0	
	569	15	584	47	4	278,148.23
Cheyenne and Arapaho Indian Agency:						
	296	0	296	0	0	92,065.33
Grand total.....	9,224	1,297	10,531	5,651	92	6,391,650.99

Outside Oklahoma supervision was exercised over oil and gas leases on tribal and restricted allotted Indian lands as follows:

Oil and gas leases on Indian lands outside Oklahoma

State and tribe	Being tested	Pro-ducing	Nonpro-ducing	Under supervision
Colorado:				
Ute tribal.....	5	3	4	7
Montana:				
Blackfeet tribal.....	1	0	3	3
Blackfeet allotted.....	0	0	10	10
Crow tribal.....	4	1	6	7
Crow allotted.....	9	2	95	97
New Mexico:				
Navajo tribal.....	3	3	9	12
Navajo, Executive order.....	2	0	2	2
Navajo allotted.....	0	0	43	43
Utah:				
Navajo, Executive order.....	1	0	1	1
Wyoming:				
Shoshone tribal.....	1	13	48	61
Shoshone allotted.....	3	8	5	13
	29	30	226	256

• Awaiting final execution.

Coal.—Supervision of coal-mining operations in 1929 included in Oklahoma 14 producing and 49 inactive leaseholds involving lands of Cherokee, Choctaw, and Creek Indians, which produced 80,101 tons of coal having a royalty and rental value of \$11,684.14, and 36 productive and 32 inactive leaseholds involving segregated Choctaw and Chickasaw lands, which produced 560,979 tons of coal having a royalty value of \$50,934.59. In Colorado it included 38 leases, 2 licenses, and 8 prospecting permits involving ceded lands of the Ute Indians, from which the rent and royalty, aggregating \$11,516.63, was credited to the tribe, and 1 tribal lease involving land in the Southern Ute Reservation. Periodic inspection was made of operations at 2 coal mines each on the Southern Navajo and Western Navajo Reservations in Arizona; 1 coal mine each on the Northern Navajo, Eastern Navajo, and Zuni Reservations in New Mexico; and 1 leasehold involving land in the Uintah and Ouray Reservation in Utah.

In cooperation with the Oklahoma Geological Survey, the geologic examination of the coal resources of the Stigler-Muskogee district, Oklahoma, begun in 1927, was continued.

Lead and zinc.—Supervision of lead and zinc mining operations involved 50 departmental leases for 6,284 acres of restricted lands of the Quapaw Indians in Oklahoma. Production from these leaseholds aggregates 14.2 per cent of the zinc and 3.9 per cent of the lead mined in the United States. The royalty for the fiscal year, \$848,219.49, was 9.63 per cent of the sale value of the ore mined. Zinc and lead were first mined on the Quapaw Reservation in 1902 in the old Lincolnville field; in 1907 the Commerce field was opened, and in 1914 the Picher field was discovered. Production has increased greatly since 1917 and now represents about 62 per cent of the total value of the lead and zinc produced in the Tri-State district. One lead and zinc lease under supervision on restricted Cherokee lands in Oklahoma was unproductive in 1928.

Miscellaneous minerals.—Inspectional and advisory service was provided in 1928 in connection with existing or proposed operations involving 2 iron-ore deposits on the Fort Apache Reservation and 2 asbestos mines on the San Carlos Reservation, Ariz.; 7 radium-ore leaseholds on the Northern Navajo Reservation, Ariz.; 3 volcanic-ash leaseholds on restricted lands of the Five Civilized Tribes, Oklahoma; and 1 marl and 3 metalliferous leaseholds on the Pyramid Lake Reservation, Nev.

OTHER COOPERATIVE WORK

The division cooperated with the Bureau of Mines and Bureau of Standards in connection with tests of mine stoppings to withstand explosions of gas and coal dust; with the Bureau of Mines in its rock-dusting, ventilation, and experimental mine programs and its oil and gas technologic investigations; with the Bureau of Reclamation in reporting on the plant and coal mine at Williston, N. Dak.; with the National Research Council on the conservation of the scientific results of drilling and the improvement of drilling methods and equipment; with the Alaska Railroad in maintaining the Eska coal mine in condition for production; and with the General Land Office

and Bureau of Mines in extinguishing fires in coal deposits on the public domain.

In cooperation with the technical committee on the scientific classification of coals of the American Society for Testing Materials, the Bureau of Mines, and the fuel research laboratories of the Mines Branch, Department of Mines, Canada, many samples of subbituminous and low-rank bituminous coals were collected by the mining engineers of the Denver, Billings, and Salt Lake City offices. These samples were submitted to the Bureau of Mines, where slacking tests and analyses were made.

STATE BENEFITS AND COST OF SUPERVISION

Leases and permits involving publicly owned mineral deposits have been issued in 21 of the States and Alaska. Such States receive under the act of February 25, 1920, directly, without expense to themselves, 37.5 per cent of all royalties, rentals, and bonuses derived from leases and permits within their respective boundaries and participate likewise in the benefits resulting from the expenditure of an additional 52.5 per cent of the funds, by the Bureau of Reclamation. Only 10 per cent of this money is retained in the Treasury of the United States.

Alaska, however, receives all net profits from the operation of Government mines as well as all royalties and rentals received from leasing operations. This money is deposited in a special fund and applied to the reimbursement of the Federal Government for the construction of railroads in that territory.

Since the inception of the mineral leasing acts a total of \$61,340,-631.84 has accrued from royalty, rent, and bonuses. More than 99.5 per cent of this amount has been paid into the United States Treasury. Twenty States and Alaska have benefited thereby without expense to themselves.

Preliminary estimates indicate that the cost of the supervisory work of the mineral leasing division averaged less than 3 per cent of the aggregate income from the leases on public and Indian lands in the fiscal year 1929. This indicates a slight increase in supervisory cost compared with 1928, chargeable principally to the decline in the total value of the minerals produced.

WORK ON PUBLICATIONS

TEXTS

BERNARD H. LANE, *Editor*

During the year 16,601 pages of manuscript were edited and prepared for printing by the section of texts, and 2,677 galley proofs and 14,814 page proofs were read and corrected. Indexes were prepared for 31 publications, covering 6,291 pages. Copy and proof or stencils for 1,262 pages of multigraph and mimeograph matter were read. At the end of the fiscal year four persons were employed in this section.

ILLUSTRATIONS

C. A. WECKERLY, Chief Illustrator

The number of drawings and photographs prepared by the section of illustrations was 2,738, including 253 maps, 864 sections and diagrams, 512 photographs, and 1,109 paleontologic drawings; 181 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany 36 reports numbered 819, to be reproduced by chromolithography, photolithography, half-tone, and zinc etching. The number of proofs received and examined was 969. At the end of the year material for illustrating 20 reports was in hand. The section consists of eight employees.

GEOLOGIC EDITING AND DRAFTING OF MAPS AND ILLUSTRATIONS

GEORGE W. STOSE, Editor of Geologic Maps

The geologic map of New Mexico was completed as a folio during the year. The Fairfield-Gettysburg (Pa.) folio was nearly completed, all but its structure maps having been printed. The maps and sections of the Coatesville-West Chester (Pa.) and Gaffney-Kings Mountain (S. C.-N. C.) folios reached stone proof. The maps of the Somerset-Windber (Pa.) and Montevallo-Columbiana (Ala.) folios were engraved. The maps of the Boston (Mass.) folio were approved for engraving. The Hollidaysburg-Huntingdon (Pa.) folio was prepared for engraving.

Maps and illustrations for 29 reports other than folios were edited for geology in the section, and 60 geologic maps and illustrations for 17 reports were drawn for geologists of the geologic branch. Material progress was made on the compilation of the geologic map of the United States. The geologic map of Virginia, compiled in the section in cooperation with the Virginia Geological Survey, was published during the year. The geologic map of Florida was edited and published for the Florida Geological Survey. The geologic map of Arkansas was edited and prepared for printing for the Arkansas Geological Survey, and the map reached color proof. The geologic map of Kentucky was edited and prepared for printing for the Kentucky Geological Survey, and the map was engraved. The compilation of the geologic map of Pennsylvania for the Pennsylvania Topographic and Geologic Survey was completed.

INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

W. M. BEAMAN, Chief

During the year 57 new topographic maps were edited and transmitted for engraving, 164 published topographic maps, 9 State maps, and 11 State index circulars were edited for reprint, and 289 maps were edited as illustrations for Geological Survey reports—a total of 530 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 432 and proofs of maps reproduced by photolithography in one to three colors numbering 168 were read. At the end of the year 109 new topographic maps were in progress of engraving and printing and 154 new topographic maps and projects were in preparation for submission for reproduction.

DISTRIBUTION*R. C. SHELSE, Chief*

A total of 334 publications, comprising 59 new books and pamphlets, 1 new geologic folio, 76 new or revised topographic and other maps, and 200 reprinted topographic and other maps, were received by the division of distribution during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 128,231 books and pamphlets, 5,140 geologic folios, and 758,542 topographic and other maps, a grand total of 891,913.

The division distributed 129,478 books and pamphlets, 9,826 geologic folios, and 835,851 maps, a grand total of 975,155, of which 8,910 geologic folios and 717,349 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$49,289.38, including \$45,050.14 for topographic and geologic maps and \$4,239.24 for geologic folios. In addition to this \$2,823.54 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$52,112.92.

The division received and answered 89,167 letters.

ENGRAVING AND PRINTING*S. J. KUBEL, Chief Engraver*

During the fiscal year 67 new topographic maps were engraved and printed, including 7 revised maps. Two fractional sheets for Trempealeau County, Wis., were also engraved but not printed. Seven new maps were photolithographed and printed, and extra copies of 2 geologic maps from folios were printed, making a total of 76 new maps printed and delivered. Corrections were engraved on the plates of 164 maps. Reprint editions of 190 engraved topographic maps and 10 photolithographed State and other maps were printed and delivered. In addition, 52 new topographic maps had been engraved and were in press June 30, and the engraving of 16 other new topographic maps was nearly completed. Of new and reprinted maps, 261 different editions, amounting to 754,592 copies, were delivered. One new geologic folio was printed, its edition amounting to 5,140 copies. Extra geologic sheets of folios numbering 690 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, the office of the Secretary of the Interior, the Bureau of Reclamation, Bureau of Education, General Land Office, National Park Service, Office of Indian Affairs, Alaska Railroad, Bureau of Pensions, St. Elizabeths Hospital, Bureau of Public Roads, Bureau of Agricultural Economics, Bureau of Plant Industry, Forest Service, Bureau of Biological Survey, Bureau of Entomology, Weather Bureau, Plant Quarantine and Control Administration, Bureau of Standards, Bureau of Lighthouses, Bureau of Foreign and Domestic Commerce, Bureau of Mines, Bureau of Fisheries, Federal Radio Commission, Department of Labor, Department of State, War Department, Post Office Department, Treasury Department, Department of

Agriculture, Department of Commerce, Interstate Commerce Commission, Federal Power Commission, National Capital Park and Planning Commission, Commission of Fine Arts, International Boundary Commission, International Exposition (Seville, Spain), Smithsonian Institution, Bureau of the Public Health Service, Office of the Chief of Engineers, United States Marine Corps, Federal Board for Vocational Education, United States Veterans' Bureau, Architect of the Capitol, Washington Suburban Sanitary District, Library of Congress, Philadelphia Regional Planning Federation, Purdue University, and the States of New Hampshire, Georgia, New Mexico, Florida, Virginia, North Carolina, Tennessee, Texas, and Delaware. This work done for other branches of the Government and State governments included many reprints, and the charges for it amounted to about \$135,000, for which the appropriation for engraving and printing geologic and topographic maps was reimbursed.

Transfer impressions numbering 400 were made during the year, including 200 furnished to contracting lithographic printers on requisition of the Government Printing Office, 5 furnished to other branches of the Government, 72 furnished to State surveys, and 123 furnished to private firms. The amount turned over to miscellaneous receipts was \$633.15.

Of contract and miscellaneous work of all kinds, 2,611,671 copies were printed. Including topographic maps and geologic folios, a grand total of 3,372,093 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 11,103 negatives (4,215 wet, of which 3,408 were for photolithographs), 60 paper, 1,807 dry, and 5,021 field negatives), 645 lantern slides, 25,931 prints (4,085 maps and diagrams and 21,846 photographs for illustrations), 3,052 zinc plates, 201 zinc etchings, 47 celluloid prints, 99 lantern slides colored, 1 transparency colored, 24 prints colored, and 1,600 prints mounted.

ADMINISTRATION

JULIAN D. SEARS, Administrative Geologist

JOHN J. MADIGAN, Chief Clerk

The administrative geologist assists the director in all phases of general administration, performs special tasks assigned to him by the director from time to time, serves as acting director in the director's absence, and has special supervision over the section of illustrations.

The chief clerk, in addition to performing the duties usually pertaining to that office, serves as budget officer and exercises administrative supervision over the division of engraving and printing, the division of distribution, the section of correspondence and records, the section of accounts, the library, and the division of field equipment.

CORRESPONDENCE AND RECORDS

C. A. KING, Chief

The work of the section of correspondence and records was of the same general character as during the fiscal year 1928.

Mails, files, and records.—During the year 101,299 pieces of mail, of which 1,864 were registered, were opened and referred. In addition 160,162 letters were received direct by the other divisions, making a total of 261,461, a decrease of 6 per cent compared with 1928. Of the letters opened in this section 20,173 contained \$49,614.94 remitted for Geological Survey publications. In addition \$2,085.97 was received as direct office cash sales, making a total of \$51,700.91. The number of ordinary letters mailed through the section was 62,351; of registered letters and packages, 952. In addition, 163,226 pieces of mail were sent out direct from other divisions. The total number of outgoing pieces of mail for the Geological Survey was 225,574.

Freight and express.—During the year 3,474 pieces of freight and express were handled, 1,798 outgoing and 1,676 incoming.

Personnel.—The roll of Secretary's appointees numbered 997 at the end of the fiscal year, 120 more than at the end of 1928. The total number of changes in personnel was 536, which included 252 appointments, 132 separations, and 152 miscellaneous changes.

During the calendar year 1927, 16,303 days of annual leave and 3,138 days of sick leave were granted, being 68 per cent of the amount of annual leave which could have been taken and 13 per cent of the sick leave it would have been possible to grant. In addition, 6,601 days of leave without pay and furloughs were granted.

LIBRARY

J. L. V. McCORD, Librarian

The year's accessions to the library comprised 13,271 books, pamphlets, and periodicals and 747 maps. The recorded loans were 6,391 books and 186 maps, in addition to those used by the 7,488 readers who consulted the library in person. The catalogue was increased by the addition of 7,616 cards. Title entries to the number of 422 were furnished to the Library of Congress for printing, the proof reading of which involved 121 galleys. Correspondence handled included 2,124 letters received and 2,063 letters sent. Letters and other writings in foreign languages to the number of 142 were translated for other divisions of the Geological Survey. Volumes to the number of 1,080 were collated and prepared for binding, and 573 newly bound volumes were labeled, plated, and shelf listed. Numerous loans were made to libraries both in Washington and in other places, and a considerable volume of reference work was done in the usual course of the library's service to specialists and students, both those in the Geological Survey and others. Work on the bibliography of North American geology has continued.

ACCOUNTS

C. K. FRANCIS, Chief

Condensed statements covering the expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

Amounts appropriated for, transferred to, and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1929.

	Funds available		Expenditures			Balance
	Amount of appropriation	Repayments on account of work performed	Total	Disbursements	Outstanding liabilities	Total
		Made	To be made			
APPROPRIATIONS						
Salaries.....	\$135,500.00			\$134,890.86	\$13,141.36	\$134,890.86
Topographic surveys.....	559,000.00	\$218,482.45	\$45,208.49	917,637.93	917,637.93	917,637.93
Geologic surveys.....	355,000.00	25,401.31	3,565.98	375,508.29	375,508.29	375,508.29
Volcanologic surveys.....	21,000.00			18,954.65	1,750.88	383,168.90
Alaskan mineral resources.....	67,000.00	161.12		57,300.64	9,765.20	207,705.53
Glacial streams.....	270,500.00	413,051.77	25,299.39	693,551.82	12,294.25	67,155.84
Classification of lands.....	191,500.00	1,293.44	75.35	193,868.79	3,526.68	705,846.07
Geologic and topographic maps of the United States.....	110,000.00	110,708.27	23,627.48	227,140.54	15,839.83	190,763.35
Preparation of illustrations.....	28,400.00	60.43		28,101.87	2.88	2,095.44
Mineral leasing.....	246,000.00	1,863.53		240,060.41	4,665.89	1,285.58
Great Smoky Mountains National Park in North Carolina and Tennessee, 1928-29.....	65,000.00	53.32		64,860.98	181.43	2,435.68
Shenandoah National Park in Virginia, 1928-29.....	35,000.00	2,831.16		37,837.88	18.53	244,756.30
U. S. Geological Survey, 1927-1929 (mineral leasing).....	20,000.00				14,850.00	65,042.41
U. S. Geological Survey, 1926-1929 (oil, gas, and oil shale).....	20,000.00			574.70	10,175.00	37,846.41
Shenandoah National Park in Virginia, 1928-30.....	11,075.22			11,080.08	45.14	14,850.00
Great Smoky Mountains National Park in North Carolina and Tennessee, 1929-30.....	2,054.16	6,072.80		7,435.97	890.99	10,749.70
	\$2,135,609.38	\$79,719.90	107,776.69	2,998,226.90	96,710.86	9,280.30
						11,075.22
						8,126.96
						3,123,105.97
						2,998,226.90
						3,094,940.76
						28,165.21
TRANSFERS						
Engineering, Bureau of Engineering (Navy Department, act Mar. 7, 1928), 1929.....	43,000.00			42,445.47		554.53
Federal Power Commission (act Mar. 7, 1928), 1929.....	4,500.00			4,381.91	66.76	51.83
Food control, Mississippi River and tributaries (War Department, act Mar. 7, 1928).....	20,240.00	400.00	342.42	23,965.56	4,057.51	28,023.07
Helium plants, Bureau of Mines (Commerce Department, act Mar. 7, 1928), 1929.....	2,300.00	266.66		2,470.60	35.56	1,969.35
Investigating peat deposits, Bureau of Mines (Commerce Department, act Feb. 15, 1929), 1929.....	10,000.00			9,887.83	110.55	60.44
Maintenance and improvement of existing river and harbor works (War Department, act Mar. 7, 1928).....	57,060.00		38.20	32,904.87	6,868.46	9,998.38
Salaries and expenses, Forest Service (Agriculture Department, act Mar. 7, 1928), 1929.....	1,121.63			1,121.63		1.02
Southern Appalachian National Park (act May 21, 1920), 1926-27.....	2,000.00			2,000.00		39,833.32
						17,284.88
						1,121.63
						2,000.00

Supervising mining operations on leased Indian lands (act Mar. 7, 1928), 1929.....

Supervising mining operations on leased Indian lands (act Mar. 4, 1929), 1929.....

Water boundary, United States and Mexico (State Department, act Feb. 15, 1928), 1929.....

Waterways treaty, United States and Great Britain (State Department, act Feb. 15, 1928), 1928-29.....

Waterways treaty, United States and Great Britain (State Department, act Mar. 4, 1928), 1929.....

60,000.00	3,114.63		63,114.63	62,937.99	156.94	63,114.63	
10,000.00	3.00		10,003.00	9,646.08	356.92	10,003.00	
18,440.00	36.07		18,476.07	18,384.53	76.46	18,460.99	15.08
61,971.11	1,426.91	161.54	63,559.56	62,063.96	885.39	63,549.35	10.21
11,800.00		22.99	11,822.99	7,066.68	2,204.24	9,270.92	2,551.97
2,447,062.12	884,967.17	106,341.74	3,440,371.03	3,278,186.77	111,529.64	3,389,716.41	50,654.62

* In addition to these appropriations an item of \$120,000 for printing and binding for the Geological Survey was contained in the appropriation act, but the account was not kept in the Geological Survey. There was also an allotment of \$14,765.10 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

† This subtotal includes \$146,400 supplemental appropriation on account of the act of May 28, 1928, and \$20,000 for standard topographic surveys for expenditure in cooperation with States or municipalities, appropriated in the second deficiency act, fiscal year 1929, approved Mar. 4, 1929.

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UNITED STATES DEPARTMENT OF THE INTERIOR

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FIFTY-FIRST ANNUAL REPORT

OF THE

*DIRECTOR OF
THE GEOLOGICAL SURVEY*

TO THE

SECRETARY OF THE INTERIOR

1930



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1930

Directors of the Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907

GEORGE OTIS SMITH, 1907-

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ANNUAL REPORT

OF THE

DIRECTOR OF THE GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 15, 1930.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1930 included 13 items, amounting to \$2,182,671. In addition \$150,000 was appropriated for printing and binding for the Geological Survey, and an allotment of \$12,960 for miscellaneous supplies was made from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of the report. The balance on July 31 was \$8,149.

The total amount of funds made available for disbursement by the Geological Survey, together with State funds directly disbursed for work administered by the Federal officials, was \$4,212,294.

A LOOK AHEAD

The work of scientific investigation is a continuing work, and its field always expands, never contracts. So in beginning a second half century of service to the Nation the United States Geological Survey looks out over wider opportunities. Its fifty-first year has been the largest and broadest year of its history in expenditures and in activities. More than \$4,000,000 was expended in highly specialized service, yielding results much varied in type but alike in contributing to the industrial development of the country and widening man's understanding of his environment.

Only an observer with shortened and narrowed vision can forecast the termination or even any curtailment of such activities as those of the Geological Survey. Like the Department of the Interior as a whole, the Geological Survey has been most intimately connected with western development, and that development is to-day far from completed. It is true that the strictly exploratory work of the Geological Survey is now in large measure confined to Alaska, but the more intensive phases of agricultural, industrial, and mining development have barely been begun in much of the western territory. Indeed, with less than half of the area of the United States covered by accurate topographic maps and with an endless variety of geologic problems awaiting attention, the exploration

of the Nation's resources can hardly be regarded as completed, and their full utilization is plainly a matter of the somewhat distant future. In a year when its engineers are blazing trails in the forests of the extreme northeast and northwest corners of the country, he is a rash prophet who sees a speedy completion of the investigations of the Geological Survey—he fails to realize that our country is still young.

Some measure of the increasing activity of the Geological Survey is afforded in the statistical record of its fifty-first year. As compared with the preceding year, the fiscal year 1930 shows increases of nearly 10 per cent in total expenditures, nearly 20 per cent in new maps issued, and nearly 30 per cent in number of book publications. The personnel, of which more than 80 per cent is professional in type, was larger than even in the years when the Bureau of Mines was a branch of the organization. Indeed, the appropriations this year exceeded by 50 per cent those for 1910, the last year before the Bureau of Mines was separated from the Geological Survey, and the total expenditures in 1930, including cooperative funds, were more than double those in 1910. This 20-year period since the separation of these two services specially directed to the promotion of the mining industry has been one of notable growth for both; yet because of the postwar economies their growth has not approached that of the industry they serve.

Fifty years ago Director King in writing on this same subject—the future of the Geological Survey—pointed out that we were then only “at the very threshold of the industrial life of the Republic”; and he outlined the need of facts as to the primary or raw-material industries. His forecast of the future growth of the mineral industry and of the scale on which the Geological Survey should carry on its fact-finding investigations has proved surprisingly far short of the facts, both estimates being less than a quarter of what we now know to be the truth. Plainly, even that far-seeing scientist failed to grasp completely the problem of the material development of our country. And so to-day the vanishing point of our look ahead also may fall far short of true perspective.

The discovery of geology by industry in recent years has placed the small corps of Government scientists under new and larger obligations. The army of geologists and engineers in commercial work necessarily look to the Federal service for the collection of geologic facts and the working out of new generalizations and principles. Practical men realize that pure research of to-day is applied science of to-morrow, and they ask their Government to furnish the fundamentals.

High-pressure industrial development throughout the country has involved an increasing demand for raw materials, with a corresponding larger need of basic engineering information. It is significant that the demand for intensive study of ore possibilities is most active to-day in the same mining States, Colorado and Nevada, where the first mining work of the Geological Survey was done, the production of the epoch-making monographs on Leadville, Eureka, and the Comstock, which had as their purpose to meet the anxious desires “of miners as well as of students of geology and economy.” The Geological Survey's special duty to help keep up the flow of

raw materials to industry is greater, not less, than it was 50 years ago.

Another phase of Governmental activity hardly foreseen in the beginning of the Geological Survey's existence is the degree to which the public domain is administered on a scientific basis. In the 20 years beginning in 1907 approximately a million dollars was spent for geologic work in areas in which the Federal Government owns coal lands. Upon this investment of appraising its property the Government is now collecting between \$400,000 and \$500,000 a year in royalties from coal mined from Government leases. The Government oil and gas leases have been still more productive, although the chief contribution of this service to the public interest has been the conservation of the natural resources belonging to the people. Even more important, however, than the enforcement of the best economic practices by the Federal engineers is their contribution to the conservation of life and health, both the zinc and the coal mines under Federal supervision showing better accident records than other mines in the same States. Larger attention to the Government's real-estate business in classifying the unused public lands and in supervising mining leases would pay good dividends.

The investigations of water resources, which at first sought simply the answer to the agricultural problem presented by the wide expanses of arid land in the West, now serve many purposes. Power development on a scale not approached elsewhere in the world has furnished added incentive to accurate stream measurement, and the quality as well as the quantity of water available for industrial and municipal use is now found an absolutely necessary subject of study in all parts of the United States. As the Secretary of the Interior has said, "In controlled water lies the future of our country." The exceptional drought of the present year has demonstrated to the public at large how essential an adequate supply of water is to modern life in all its phases. This field of investigation is expanding.

A similar evolution has taken place in topographic mapping. The work that produced the small-scale reconnaissance type of map has given place to more and more detailed surveying, with a product that can be used in planning engineering projects. New standards and new methods are constantly improving these maps, which as yet cover less than half the area of the United States. There is urgent need of completing these maps for use by this generation, but even were that end attained, the expansion of industrial projects and the advance of urban developments would necessitate a continuing program of revision and resurvey to make these "mother maps" of full and permanent utility.

The present accumulation of unanswered requests for needed work, the embarrassing abundance of untouched problems, and the broad expanse of unoccupied fields afford little basis indeed for any feeling that the activity of the Geological Survey will soon reach any state of diminishing returns. Rather, the prospect of investigations that promise large returns of public benefit becomes more inviting as the work expands. Not less attractive, too, is the field of scientific inquiry that yields products needed for educational and cultural use. Popular interest in science makes a legitimate demand upon the Federal scientific bureaus.

In short, the Geological Survey is a fact-finding agency, collecting and presenting the information regarding the country's natural resources necessary for the formulation of a national plan. The demand for such facts will continue as long as our people continue to carry on commerce and industry by a more intensive conquest of nature.

That "we are but started as a Nation" was the text of Secretary Wilbur's message at the formal opening of the project of harnessing the Colorado River. And every citizen of vision realizes that the future of this continent-wide country, blessed though it is with most of the natural advantages, must be built on more substantial foundations than those laid in the days of pioneer settlement and exploitation. Our wealth of resources must be more wisely used in the light of better science and better engineering. The prospects for winning a prosperity more generally distributed and more firmly established furnish the incentive for applying science to national welfare.

The one hundredth report of the Director of the United States Geological Survey may be expected to be simply a report of progress.

PUBLICATIONS OF THE YEAR

The following publications were issued during the fiscal year 1930:

ANNUAL REPORT

Fiftieth Annual Report of the Director of the Geological Survey.

MONOGRAPH

55. Titanotheres of ancient Wyoming, Dakota, and Nebraska, by H. F. Osborn.

PROFESSIONAL PAPERS

154. Shorter contributions to general geology, 1928.

154-A. Moraines and shore lines of the Lake Superior Basin, by Frank Leverett.

155. The flora of the Denver and associated formations of Colorado, by F. H. Knowlton.

156. Revision of the lower Eocene Wilcox flora of the Southeastern States, with descriptions of new species, chiefly from Tennessee and Kentucky, by E. W. Berry.

158. Shorter contributions to general geology, 1929.

158-B. The contact of the Fox Hills and Lance formations, by C. E. Dobbins and J. B. Reeside, Jr.

158-C. The Helderberg group of parts of West Virginia and Virginia, by F. M. Swartz.

158-D. Petrography of the Pioche district, Lincoln County, Nev., by J. L. Gillson.

158-E. The varves and climate of the Green River epoch, by W. H. Bradley.

158-F. Contact metamorphism of the rocks in the Pend Oreille district, northern Idaho, by J. L. Gillson.

158-G. Early Pleistocene glaciation in Idaho, by C. P. Ross.

158-H. The flora of the Frontier formation, by E. W. Berry.

158-I. Borate minerals from the Kramer district, Mohave Desert, Calif., by W. T. Schaller.

165-A. Lithologic studies of fine-grained Upper Cretaceous sedimentary rocks of the Black Hills region, by W. W. Rubey.

165-B. A flora of Green River age in the Wind River Basin of Wyoming, by E. W. Berry.

BULLETINS

797. Mineral resources of Alaska, report on progress of investigations in 1926, by P. S. Smith and others.
799. Geology of the McCall's Ferry-Quarryville district, Pa., by E. B. Knopf and A. I. Jonas.
800. Geology and mineral deposits of southeastern Alaska, by A. F. Buddington and Theodore Chapin.
806. Contributions to economic geology (short papers and preliminary reports), 1928. Part II, Mineral fuels.
808. Geology of the De Queen and Caddo Gap quadrangles, Ark., by H. D. Miser and A. H. Purdue.
809. Formulas and tables for the construction of polyconic projections, compiled by C. H. Birdseye.
810. Mineral resources of Alaska, report on progress of investigations in 1927, by P. S. Smith and others.
- 810-B. The Chandalar-Sheenjek district, Alaska, by J. B. Mertie, jr.
- 810-C. The Mount Spurr region, Alaska, by S. R. Capps.
811. Contributions to economic geology (short papers and preliminary reports), 1929, Part I, Metals and nonmetals except fuels.
- 811-A. The New World or Cooke City mining district, Park County, Mont., by T. S. Lovering.
- 811-B. Recent mining developments in the Greede district, Colo., by E. S. Larsen.
- 811-C. Indiana oolitic limestone, relation of its natural features to its commercial grading, by G. F. Loughlin.
- 811-D. The Rawlins, Shirley, and Seminole iron-ore deposits, Carbon County, Wyo., by T. S. Lovering.
- 811-E. Tertiary volcanic tuffs and sandstones used as building stones in the upper Salmon River Valley, Idaho, by C. H. Behre, jr.
- 812-A. The Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Mont., by C. E. Dobbin.
- 812-B. The Kevin-Sunburst oil field and other possibilities of oil and gas in the Sweetgrass arch, Mont., by A. J. Collier.
- 812-C. Geology and coal resources of the Meeker quadrangle, Moffat and Rio Blanco Counties, Colo., by E. T. Hancock and J. B. Eby.
- 812-D. Geology and oil resources along the southern border of San Joaquin Valley, Calif., by H. W. Hoots.
- 813-A. Mineral industry of Alaska in 1928 and administrative report, by P. S. Smith (with selected list of Geological Survey publications on Alaska).
- 813-B. The Chakachamna-Stony region, Alaska, by S. R. Capps.
- 813-C. Mining in the Fortymile district, Alaska, by J. B. Mertie, jr.
816. Geology of the Eagle-Circle district, Alaska, by J. B. Mertie, jr.
- 822-B. The Granby anticline, Grand County, Colorado, by T. S. Lovering.

WATER-SUPPLY PAPERS

578. The Mohave Desert region, Calif., a geographic, geologic, and hydrologic reconnaissance, by D. G. Thompson.
597. Contributions to the hydrology of the United States, 1928.
598. Geology and ground-water resources of North Dakota, by H. E. Simpson, with a discussion of the chemical character of the water, by H. B. Riffenburg.
599. Ground water in Yellowstone and Treasure Counties, Mont., by G. M. Hall and C. S. Howard.
600. Geology and ground-water resources of central and southern Rosebud County, Mont., by B. C. Renick, with chemical analyses of the waters by H. B. Riffenburg.
601. Surface water supply of the United States, 1925, Part I, North Atlantic slope drainage basins.
602. Surface water supply of the United States, 1925, Part II, South Atlantic slope and eastern Gulf of Mexico basins.
603. Surface water supply of the United States, 1925, Part III, Ohio River Basin.
604. Surface water supply of the United States, 1925, Part IV, St. Lawrence River Basin.

605. Surface water supply of the United States, 1925, Part V, Hudson Bay and upper Mississippi River basins.
606. Surface water supply of the United States, 1925, Part VI, Missouri River Basin.
607. Surface water supply of the United States, 1925, Part VII, Lower Mississippi River Basin.
608. Surface water supply of the United States, 1925, Part VIII, Western Gulf of Mexico basins.
609. Surface water supply of the United States, 1925, Part IX, Colorado River Basin.
610. Surface water supply of the United States, 1925, Part X, The Great Basin.
613. Surface water supply of the United States, 1925, Part XII, North Pacific slope drainage basins: B, Snake River Basin.
614. Surface water supply of the United States, 1925, Part XII, North Pacific slope drainage basins: C, Pacific slope drainage basins in Oregon and lower Columbia River Basin.
615. Surface water supply of Hawaii, July 1, 1924, to June 30, 1925.
616. Geology and water resources of the Kau district, Hawaii (including parts of Kilauea and Mauna Loa Volcanoes), by H. T. Stearns and W. O. Clark, with a chapter on ground water in the Hawaiian Islands, by O. E. Meinzer.
617. Upper Colorado River and its utilization, by Robert Follansbee.
618. The Green River and its utilization, by Ralf R. Woolley.
619. Geology and water resources of the Mokelumne area, Calif., by H. T. Stearns, T. W. Robinson, and G. H. Taylor.
621. Surface water supply of the United States, 1926, Part I, North Atlantic slope drainage basins.
624. Surface water supply of the United States, 1926, Part IV, St. Lawrence River Basin.
625. Surface water supply of the United States, 1926, Part V, Hudson Bay and upper Mississippi River Basins.
626. Surface water supply of the United States, 1926, Part VI, Missouri River Basin.
627. Surface water supply of the United States, 1926, Part VII, Lower Mississippi River Basin.
629. Surface water supply of the United States, 1926, Part IX, Colorado River Basin.
632. Surface water supply of the United States, 1926, Part XII, North Pacific slope drainage basins: A, Pacific slope basins in Washington and upper Columbia River Basin.
- 636-B. Suspended matter in the Colorado River in 1925-1928, by C. S. Howard.
- 636-C. The New England flood of November, 1927, by H. B. Kinnison.
- 636-D. Surface water supply of the San Joaquin River Basin, Calif., 1895-1927, by H. D. McGlashan.
- 636-E. Surface water supply of Pacific slope basins in southern California, 1894-1927, by H. D. McGlashan.
- 636-F. Water-power resources of the Umpqua River and its tributaries, Oreg., by B. E. Jones and H. T. Stearns.
- 637-A. Surface water supply of minor San Francisco Bay, northern Pacific, and Great Basins in California, 1895-1927, by H. D. McGlashan.

GEOLOGIC FOLIO

225. Fairfield-Gettysburg, Pa., by G. W. Stose and F. Bascom.

TOPOGRAPHIC AND OTHER MAPS

[The figures in parentheses indicate limiting parallels and meridians of the areas covered]

Alabama:

Barton (34° 30'-34° 45'; 87° 45'-88°).

Alaska:

Valdez and vicinity (60° 55'-61° 15'; 146° 10'-146° 55').

Arizona:

Aztec (32° 45'-33°; 113° 15'-113° 30').

Bridge Canyon (35° 37' 30''-35° 52' 30''; 113° 30'-113° 45').

Yucca (34° 45'-35°; 114°-114° 15').

Arkansas-Louisiana:

El Dorado (33° – 33° 15'; 92° 30'– 92° 45').

California:

Allensworth (35° 45'– 35° 52' 30''; 119° 22' 30''– 119° 30').

Alpaugh (35° 52' 30''– 36° ; 119° 22' 30''– 119° 30').

Delano (35° 45'– 35° 52' 30''; 119° 7' 30''– 119° 15').

Ducor (35° 52' 30''– 36° ; 119° – 119° 7' 30'').

Famoso (35° 30'– 35° 37' 30''; 119° 7' 30''– 119° 15').

Hacienda Ranch (35° 45'– 35° 52' 30''; 119° 30'– 119° 37' 30'').

Inglewood (33° 54'– 34° ; 118° 18'– 118° 24').

Pixley (35° 52' 30''– 36° ; 119° 15'– 119° 22' 30'').

Porterville (36° – 36° 7' 30''; 119° – 119° 7' 30'').

Quincy School (35° 45'– 35° 52' 30''; 118° 52' 30''– 119°).

Richgrove (35° 45'– 35° 52' 30''; 119° – 119° 7' 30'').

Sausalito School (35° 52' 30''– 36° ; 119° 7' 30''– 119° 15').

State, scale 1 inch=8 miles.

Stone (35° 45'– 35° 52' 30''; 119° 15'– 119° 22' 30'').

Stratford (36° 7' 30''– 36° 15'; 119° 45'– 119° 52' 30'').

West Alpaugh (35° 52' 30''– 36° ; 119° 30'– 119° 37' 30'').

Colorado (see also Great Plains):

Grand Valley (39° 15'– 39° 30'; 108° – 108° 15').

Northwestern Colorado (land classification; 39° – 41° ; 106° to Utah line).

Roan Creek (39° 15'– 39° 30'; 108° 15'– 108° 30').

Great Plains:

Land classification of central Great Plains, sheets 4 and 5 (eastern Colorado).

Land classification of northern Great Plains (Montana, North Dakota, South Dakota, Wyoming). 8 sheets.

Hawaii:

Mauna Kea (19° 45'– 20° ; 155° 15'– 155° 30').

Iaho:

Casto (44° 30'– 44° 45'; 114° 30'– 115°).

Illinois (see also Kentucky-Illinois):

Blue Island (41° 37' 30''– 41° 45'; 87° 37' 30''– 87° 45').

Brisbane (41° 22' 30''– 41° 30'; 87° 52' 30''– 88°).

Englewood (41° 45'– 41° 52' 30''; 87° 37' 30''– 87° 45').

Frankfort (41° 22' 30''– 41° 30'; 87° 45'– 87° 52' 30'').

Harvey (41° 30'– 41° 37' 30''; 87° 37' 30''– 87° 45').

Mokena (41° 30'– 41° 37' 30''; 87° 52' 30''– 88°).

Mount Sterling (39° 45'– 40° ; 90° 45'– 91°).

Park Ridge (42° – 42° 7' 30''; 87° 45'– 87° 52' 30'').

Springfield (39° 45'– 40° ; 89° 30'– 89° 45').

Illinois-Indiana:

Calumet City (41° 30'– 41° 37' 30''; 87° 30'– 87° 37' 30'').

Calumet Lake (41° 37' 30''– 41° 45'; 87° 30'– 87° 37' 30'').

Dyer (41° 22' 30''– 41° 30'; 87° 30'– 87° 37' 30'').

Indiana (see Illinois-Indiana; Michigan-Indiana):**Kentucky. (See also Tennessee-Kentucky):**

Lexington (38° – 38° 15'; 84° 15'– 84° 30').

Taylorsville (38° – 38° 15'; 85° 15'– 85° 30').

Kentucky-Illinois:

Paducah (37° – 37° 15'; 88° 30'– 88° 45').

Kentucky-Ohio:

Greenup (38° 30'– 38° 45'; 82° 45'– 83°).

Kentucky-Tennessee-Virginia:

Middlesboro (36° 30'– 36° 45'; 83° 30'– 83° 45').

Maine:

Katahdin (45° 45'– 46° ; 68° 45'– 69°).

Michigan:

Corunna (42° 45'– 43° ; 84° – 84° 15').

Mount Clemens (42° 30'– 42° 45'; 82° 45'– 83°).

Michigan-Indiana:

Three Oaks (41° 45'– 42° ; 86° 30'– 86° 50').

Minnesota. (See Wisconsin-Minnesota.)**Montana. (See Great Plains.)**

Nevada:

Roberts Mountains (39°-40°; 116°-117°).

New Hampshire:

Lovewell Mountain (43°-43° 15'; 72°-72° 15').

Ossipee Lake (43°-45°-44°; 71°-71° 15').

New York:

Cohoes (42° 45'-43°; 73° 30'-73° 45').

Schenectady (42° 45'-43°; 73° 45'-74°).

Strum (44° 30'-44° 45'; 91° 15'-91° 30').

North Dakota. (See also Great Plains):

Balfour (47° 45'-48°; 100° 30'-100° 45').

Benedict (47° 45'-48°; 101°-101° 15').

Coleharbor (47° 30'-47° 45'; 101°-101° 15').

Kongsberg (47° 45'-48°; 100° 45'-101°).

Sawyer (48°-48° 15'; 101°-101° 15').

Ohio. (See Kentucky-Ohio.)**Oregon:**

Bend (44°-44° 30'; 121°-121° 30').

Mill City (44° 30'-45°; 122°-122° 30').

Oregon-Washington:

Hood River (45° 30'-46°; 121° 30'-122°).

Pennsylvania:

Berlin (39° 45'-40°; 78° 45'-79°).

Centre Hall (40° 45'-41°; 77° 30'-77° 45').

South Carolina:

State, scale 1 inch=8 miles.

South Dakota. (See Great Plains.)**Tennessee (see also Kentucky-Tennessee-Virginia):**

Gainesboro (36° 15'-36° 30'; 85° 30'-85° 45').

Tennessee-Kentucky:

Byrdstown (36° 30'-36° 45'; 85°-85° 15').

Lillydale (36° 30'-36° 45'; 85° 15'-85° 30').

Texas:

Boyd (33°-33° 15'; 97° 30'-97° 45').

Farmersville (33°-33° 15'; 96° 15'-96° 30').

Frisco (33°-33° 15'; 96° 45'-97°).

Hunter (29° 45'-30°; 98°-98° 15').

Luling (29° 30'-29° 45'; 97° 30'-97° 45').

McKinney (33°-33° 15'; 96° 30'-96° 45').

Marble Falls (30° 30'-30° 45'; 98° 15'-98° 30').

Simmons (28° 15'-28° 30'; 98° 15'-98° 30').

Virginia. (See Kentucky-Tennessee-Virginia.)**Washington. (See Oregon-Washington.)****Wisconsin:**

North Bend (44°-44° 15'; 91°-91° 15').

Whitehall (44° 15'-44° 30'; 91° 15'-91° 30').

Wisconsin-Minnesota:

Fountain City (44°-44° 15'; 91° 30'-91° 45').

Galesville (44°-44° 15'; 90° 15'-91° 30').

La Crescent (43° 45'-44°; 91° 15'-91° 30').

Wyoming. (See Great Plains.)**THE YEAR'S OPERATIONS**

The principal activity of the director outside of Washington was his service as the representative of the Secretary of the Interior in helping the oil operators to perfect their development plans for the Kettleman Hills field, California, in which the Government is a large owner. He also continued his service as chairman of the advisory committee selected by the four Cabinet officers forming the Federal Oil Conservation Board, to assist them in their general study of the petroleum problem, and as chairman of the Naval Oil Reserve Commission. In addition to this service he made addresses

r informal talks at scientific, technical, and other meetings and contributed articles to the press, in order to give wider circulation to some of the salient results of the Geological Survey's work that are of general public interest. A list of these addresses and articles is given below.

ADDRESSES

The California situation, National Petroleum Association, Atlantic City, September 19.

American coal industry, American Institute of Mining and Metallurgical Engineers, San Francisco, Calif., October 7.

Development of the American coal industry, 1913-1928, prepared in collaboration with F. G. Tryon, World Engineering Congress, Tokyo, Japan, October 29.

International fellowship of engineers, World Engineering Congress, Tokyo, Japan, October 31.

Address, Washington Society of Engineers, Washington, D. C., February 5.

Discussion of unit operation, American Institute of Mining and Metallurgical Engineers, New York City, February 18.

Address, Women's Auxiliary, American Institute of Mining and Metallurgical Engineers, Washington, D. C., March 1.

Address, York Engineering Society, York, Pa., March 7.

The engineer as an economist, Engineers Club, Philadelphia, Pa., March 18.

Address, Washington Society of Military Engineers, Washington, D. C., March 19.

The university and natural resources, University of Arizona, Tucson, Ariz., April 24.

Petroleum resources of the United States, National Industrial Conference Board, New York City, May 15.

Address, Butte section, American Institute of Mining and Metallurgical Engineers, Butte, Mont., June 5.

The engineer's larger opportunity, Montana School of Mines, Butte, Mont., June 6.

Better citizens for Montana (not presented in person), University of Montana, Missoula, Mont., June 9.

Address, Lions Club, Washington, D. C., June 25.

ARTICLES

Agree on two domes, North Dome in doubt, California Oil World, July 18.

Letter to the editor, Coalinga Daily Record, August 9.

How does America stand in natural resources? Forbes, September 15.

California cooperation, California Oil World, December 26.

Practical conservation, United States Daily, February 5.

Gas conservation sorely needed in California, Oil and Gas Journal, February 20.

Natural resources, 1929, American Journal of Sociology, May.

Another year of cooperative effort, Oil Bulletin, June.

The branch chiefs also represented the Geological Survey at technical and other meetings, and some of them made addresses, a few of which are listed below:

Geology and the State, by W. C. Mendenhall, twenty-fifth anniversary of Illinois Geological Survey, Urbana, Ill., April 30.

Mountain building in Alaska, by P. S. Smith.

The geologic heritage of Alaska, by P. S. Smith.

The necessity of preserving level bench marks, by J. G. Staack, County Surveyors' Institute, Columbus, Ohio, February 6.

The most notable publication of the year was Monograph 55, Titanotheres of Ancient Wyoming, Dakota, and Nebraska, by Henry Fairfield Osborn, a monumental work in two volumes comprising 953 pages, 237 plates, and 797 text figures. This work is the culmi-

nation of investigations begun about 50 years ago, soon after the Geological Survey was organized. The study was undertaken by the distinguished paleontologist Othniel C. Marsh and after his death, in 1900, was assigned to Professor Osborn. The task has been long and difficult, but the results have transformed our knowledge of the early Tertiary geology of the Rocky Mountain basin region, and the history of the titanotheres family in its evolution from small, weak forms to giant "thunder beasts" has afforded a unique opportunity to acquire new information as to the actual modes of evolution and to revise our theories as to the causes of evolution and of extinction.

A brief statement of the scope and extent of the Geological Survey's activities follows:

GEOLOGIC WORK

About 125 geologists and associated chemists and physicists were engaged in the study of problems connected with the rock crust of the earth and its resources available for the citizens of the United States. Mineral fuels, fertilizers, and structural materials were the subjects of the principal investigations, for the continued production of these raw materials is essential to present-day civilization.

Geologic work was done in 30 States and Hawaii, and, as in the past, there was active cooperation with State surveys, as well as with other Government agencies and nongovernmental scientific associations.

EXPLORATIONS IN ALASKA

In Alaska the Geological Survey performs pioneer service under frontier conditions. In the field season of 1929 a geologic reconnaissance was made near the headwaters of the Copper River, combined geologic and topographic reconnaissance surveys were conducted in the Lake Clark-Mulchatna region, and geologic work of a reconnaissance nature was continued in the Yukon-Tanana region, these three projects including about 3,600 square miles. The Navy Department again cooperated in aerial photographic work in southeastern Alaska, adding about 12,000 square miles to the 10,000 square miles photographed from the air in 1926. The resulting prints are now available for compiling drainage maps which can be utilized as bases for future topographic mapping.

Investigation of mineral resources and the collection of mining statistics were continued in connection with the field work of geologists and were combined with the supervision of operations under coal and oil leases on Government lands by the small staff at the two local offices maintained by the Geological Survey.

At the end of the fiscal year work on seven field projects had been started, including reconnaissance topographic mapping in the Ketchikan district, geologic and mining studies in the Taku Valley near Juneau, geologic investigations in the vicinity of the Alaska Railroad, geologic reconnaissance mapping of part of the Chulitna Valley and adjacent parts of Broad Pass, exploratory and reconnaissance topographic surveys in the Nushagak and adjacent areas of southwestern Alaska, geologic reconnaissance of the region lying north of the Yukon and adjacent to the international boundary, and a study of the general mining developments and conditions, with visits to such of the camps as time and other conditions permit.

TOPOGRAPHIC MAPPING

The topographic maps prepared as an essential base for detailed geologic mapping have proved to have hundreds of other uses, and the general realization of their value is shown in the increasing funds made available by States and other Federal units for cooperation in this work. The State cooperative funds during the year amounted to \$441,851.91 and were furnished by 25 States, 8 counties, and Hawaii. The area mapped during the year amounted to 22,397 square miles, and the total area now mapped is 1,344,158 square miles. Nine

States, the District of Columbia, and Hawaii are completely mapped, and the percentages in the other States range from 8 in Florida to 90.8 in New Hampshire. Of the continental United States, exclusive of Alaska, 44.2 per cent has been mapped. River surveys amounting to 131 linear miles were also made. Some of the work in Washington and Hawaii was done by aerial photography. Surveys of the boundaries of the proposed Great Smoky Mountains and Shenandoah National Parks were continued. The other Government units for which surveys were made included the Forest Service, Bureau of Yards and Docks, Corps of Engineers, Navy Department, War Department, State Department, Biological Survey, and National Park Service.

INVESTIGATIONS OF WATER RESOURCES

The work on water resources consists primarily of research and investigation—the collection of facts in regard to the quantity, quality, availability, and utilization of water. The growing realization of the necessity of reliable data as a basis for water development of any kind is reflected in the persistent and increasing demand for such facts. The work is done largely in cooperation with other Government organizations, with State, county, and municipal agencies, and with permittees and licensees of the Federal Power Commission. The amount expended by State, county, and municipal agencies for such work during the year, in part directly and in part through the Geological Survey, was \$397,971.25. This sum covered work in 34 States and Hawaii. Including the cooperative work, the study of surface waters, which consists primarily of the measurement of the flow of streams, was carried on in 47 States and Hawaii, in which at the end of the year 2,426 gaging stations were being maintained. The work on ground-water resources has been planned to meet the more and more exacting public demand for precise information with increasing need for the water. Investigations relating to ground water and power or reservoir sites were made in 26 States and Hawaii. Research into the principles of hydrology has been continued in order to provide a more secure basis for ground-water investigations. Cooperation was continued with well drillers' associations with a view to developing higher standards and better results in water-well drilling. The work on quality of water involved the examination of 1,180 samples of water. The investigations of power resources included the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants and reports on the origin of the coal used in such plants and the developed water power of the United States.

WORK IN CLASSIFYING AND LEASING PUBLIC LANDS

The classification of public lands with respect to their mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands were continued in 20 States and Alaska. The number of cases involving land classification acted on during the year was 17,379, and the results accomplished include net decreases of 58,126 acres in the area of outstanding coal withdrawals, of 1,881 acres in outstanding petroleum withdrawals, and of 280 acres in outstanding phosphate reserves. At the end of the year the total area classified as mineral in character amounted to 36,433,446 acres in 14 States and Alaska and the outstanding mineral withdrawals to 46,579,306 acres in 14 States. Definition of the "known geologic structure" of producing oil and gas fields was continued, and at the end of the year the net area so defined was 725,419 acres in seven States. Investigations to obtain information for classifying public land with respect to its value for the development of water power were made in one State. There was a net increase of 108,295 acres in the area included in power reserves, making a total of 6,587,865 acres in 20 States and Alaska, on which about 15,000,000 continuous horsepower can be developed. The net decrease in enlarged-homestead designations was 7,583,110 acres, making a total outstanding of 317,719,176 acres in 14 States, and the net increase in stock-raising homestead designations was 1,279,420 acres, making a total outstanding of 121,545,990 acres in 19 States. There was a net increase of 11,392 acres in public water reserves, and the total outstanding is now 420,823 acres in 12 States. The supervisory work on public lands subject to the mineral leasing laws was increased by the issuance of 120 leases, 320 permits, and 15 licenses, covering 559,987 acres, and decreased

by 10,184 cancellations and expirations of leases, permits, and licenses. The production of petroleum on such lands during the year was 27,419,509 barrels, of natural gas 39,124,116,000 cubic feet, and of gasoline 101,470,301 gallons, on which the royalty, rentals, and bonuses amounted to \$4,148,608. The production of coal on such lands was 3,033,076 tons, of phosphate rock 22,101 tons, and of sodium salts 29,322 tons, on which the royalty, rentals, and bonuses amounted to \$512,376. Supervision over oil and gas operations on naval petroleum reserves was continued, and the total production was 6,978,922 barrels of petroleum, 6,817,458,000 cubic feet of natural gas, and 25,567,986 gallons of gasoline, on which the royalty value was \$1,612,167. Inspectional, regulatory, and advisory service was rendered in connection with the leasing of mineral deposits on Indian lands in eight States.

PUBLICATIONS

The increase in book publications of the year over other years was notable both in number and in pages, consisting of a gain of 29 per cent in number and 70 per cent in pages. Corresponding increases were shown in the manuscript edited and prepared for printing, the proofs read and indexes made, and the illustrations prepared. There were also increases of 18 per cent in maps published and of 174 per cent in maps edited and transmitted for engraving. The publications of the year consisted of 77 books and pamphlets of the regular series, 91 new or revised maps, 145 reprinted maps, and numerous circulars, lists of publications, etc. The total number of pages in the new book publications was 12,577. In addition to the publications in the regular series, 45 brief reports were issued in mimeographed form as memoranda for the press. The publications distributed numbered 833,343, of which 4,197 folios and 691,610 maps were sold for \$46,480.18.

GEOLOGIC BRANCH

W. C. MENDENHALL, *Chief Geologist*

ORGANIZATION AND PERSONNEL

The administration of the geologic branch continued during the year to be conducted through 10 sections, as follows:

Paleontology and stratigraphy, T. W. Stanton, geologist, in charge.
 Geology of metalliferous deposits, G. F. Loughlin, geologist, in charge.
 Geology of areal and nonmetalliferous deposits, G. R. Mansfield, geologist, in charge.
 Geology of iron and steel metals, E. F. Burchard, geologist, in charge.
 Glacial geology, W. C. Alden, geologist, in charge.
 Coastal Plain investigations, L. W. Stephenson, geologist, in charge.
 Geology of fuels, H. D. Miser, geologist, in charge.
 Volcanology, T. A. Jaggar, jr., volcanologist, in charge.
 Petrology, C. S. Ross, geologist, in charge.
 Chemistry and physics, George Steiger, chemist, in charge.

Claude E. Siebenthal, who had been ill for some months, was retired because of disability early in the fiscal year. Mr. Siebenthal died in Florida March 1, 1930. On June 20, 1930, R. C. Wells succeeded George Steiger as chief chemist, in charge of the section of chemistry and physics.

The professional force at the end of the year included 116 geologists of various grades, many of whom are not employed continuously, 7 chemists, and 2 physicists. During the year there were 14 appointments (1 associate geologist, 3 assistant geologists, and 10 junior geologists), 1 retirement, 2 transfers to other bureaus, and 2 resignations (1 geologist and 1 chemist). The subprofessional force comprises 5 draftsmen (1 temporary), 9 preparators of fossils (1 temporary), and 1 chief scientific aid, the changes being 1 addition from the clerical force, 2 appointments (preparators of fossils),

and 2 resignations (temporary draftsman and laboratory mechanic). In the clerical force there were 4 accessions and 4 separations, leaving a total of 27 clerks of various grades, 3 of whom are temporary.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the geologic branch for the fiscal year were as follows:

Geologic surveys	\$350, 000
Classification of lands	17, 500
Volcanologic surveys	21, 000
Investigating potash deposits	12, 500
Repayments from other Federal departments	6, 413
Repayments from State, city, and other cooperating organizations	28, 692
	<hr/>
	436, 105

The expenditures from these funds may be classified approximately as follows:

Geologic investigations (economic and scientific, including volcanologic)	\$329,233
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc	105, 489
Unexpended balances	1,383
	<hr/>
	436, 105

STATE COOPERATION

The first Director of the United States Geological Survey, in a communication to the State geologist of one of the Mid-Western States in 1880, said:

The director desires to announce to you that he urges the inauguration and continuance of State surveys and wishes to cooperate with them to the mutual advantage of both.

Since that utterance of 50 years ago cooperation with State surveys has been an important element in the activities of the Federal Survey.

Cooperation between organizations engaged in work with similar objectives needs no advocacy. The State surveys are engaged in applying geology to the service of their respective States. The Federal Survey is engaged in rendering a similar service to the United States as a whole. Staffs, equipment, and available funds differ as between different State organizations and between these and the Federal organization. Each at any particular time may be relatively strong in certain particulars and relatively weak in others, for staffs are not permanent nor of uniform quality, and there are variations in the ability and the desire of legislatures to support the work. Obviously team work will be productive of more results, of higher quality, than isolated effort which disregards what others are doing in similar and perhaps adjacent fields.

The active State Geologists' Association provides a medium for the exchange of ideas and experiences between the representatives of the State organizations and thus fosters the efficiency of each. The Federal Survey, working sympathetically with the association, participates in and contributes to the exchange of ideas. It maintains direct cooperation with many of the State organizations—chiefly,

to be sure, in topographic mapping and work on water resources, partly because the States are usually not equipped for work of this sort, but also because by cooperating on the cost-sharing basis the needed base maps and stream-flow records become available to the States at a great saving in cost. Geologic cooperation is also maintained, though on a less extensive scale. Because the State surveys have their own geologic staffs, large or small, they have less need for geologic aid than for aid in other branches of the work. But as the Federal Survey geologic staff sometimes includes specialists in fields not represented on the staff of a State, it may be advantageous to the State to procure the services of these specialists through cooperation rather than to attempt development of such specialists on their own staffs—a process that may take several years. Again, many State geologic problems are also interstate, for State boundaries do not follow geologic boundaries. Many of these problems can be effectively attacked by cooperation between the geologic staffs of adjoining States. Others have phases that can not be solved without bringing together the evidence from broad areas overrunning several State boundaries. In such problems the Federal Geological Survey may serve as a general integrating medium and thus render material aid to each State affected. Yet too often, by reason of an inadequate staff, it has not been possible for the Federal Survey to extend this appropriate and highly desirable type of cooperation to the States.

In some States there is either no official geologic survey or else an organization with only a small staff. Such States materially augment the work which they can do alone or which the Federal Survey could do alone by inviting the national organization to undertake economic or other surveys on a cost-sharing basis. The Federal Government and the State each contributes to the cost of the work, which is done under Federal auspices and by the Federal Survey staff, the resulting reports being printed either by the State or by the Government, as may be mutually agreed upon.

Many State geologists, past and present, have also at some time been members of the United States Geological Survey staff. This background of common experience does much to facilitate cooperation, to establish common standards, and to render the work, both State and national, of the greatest scientific and economic value.

WORK ON POTASH

On June 30, 1930, the Geological Survey completed its share of the fourth year of the potash investigations under the act approved June 25, 1926 (44 Stat. 768) as amended March 3, 1927 (44 Stat. 1388). This act authorized a 5-year program of cooperative core drilling, in which the Geological Survey was to select drilling sites, make chemical and mineralogical tests of the material obtained by drilling, and announce the results, and the Bureau of Mines was to execute contracts and to conduct drilling operations.

The selection of drilling sites has involved, in addition to the study and testing of Government cores, the collection and examination of thousands of samples of cuttings from oil wells in the Permian basin of Texas and New Mexico. (See report of the chemical laboratory, p. 26.) The examination of these cuttings has hitherto consisted principally of preliminary qualitative

chemical examinations, followed by quantitative determinations of potash in the more promising samples. This method, which provided satisfactory clues for the location of polyhalite beds, was found not to apply so well to the location of possible sources of the more soluble and more desirable potash minerals, such as sylvite, langbeinite, and carnallite. During this year, therefore, special attention has been paid to petrographic study of well cuttings to detect the presence of such minerals. This work, which also has involved thousands of determinations, has proved moderately effective and has been an influential factor in the location of all five drilling sites selected and recommended to the Bureau of Mines this year. Three of these sites were in New Mexico and two in Texas. Of the 21 sites thus far selected for drilling under the 5-year program 10 have been in New Mexico and 11 in Texas.

Cores were received from five Government tests, Nos. 12 to 16, and analytical and mineralogical work was completed on three of these; work on the last two was finished a few days after the end of the fiscal year.

Private core drilling was less active during the year, only two cores having been transmitted from permittees in New Mexico. This apparent slackening in private activity was due, however, to the change from core drilling to shaft sinking by the United States Potash Co. in New Mexico, the company that has done most of the core drilling. The activities of this company, which it is hoped may lead to early potash production in the New Mexico field, are attributable to the interest aroused by the Geological Survey's early announcements of potash discoveries in the Permian basin and more specifically to the subsequent discovery of grains of sylvite in cuttings from the McNutt No. 1 well in Eddy County, N. Mex., announced by the Geological Survey in April, 1926.

Press announcements of findings in four of the Government wells (Nos. 11-14) have been issued during the year. These indicate the discovery of beds of polyhalite of minable thickness and depth in wells 12 to 14 and of two areas (wells 12 and 13) in which sylvite, carnallite, or langbeinite is present, though probably not in sufficient quantity for commercial development.

A paper on the mineralogy of the drill cores from the potash field of New Mexico and Texas, by W. T. Schaller and E. P. Henderson, was submitted for publication. A paper on potash in the United States by G. R. Mansfield, was published in the *Journal of Chemical Education*.

WORK IN GEOLOGY BY STATES

ALABAMA

Studies of the iron ores of the State were continued by E. F. Burchard in cooperation with the Geological Survey of Alabama, and progress was made on the preparation of a cooperative report on the red ores of the northeastern part of the State. A short paper by Julia Gardner on a new Eocene *Leda* from Black Bluff was published in the *Journal of the Washington Academy of Sciences*.

ARIZONA

Reconnaissance stratigraphic examinations were made by H. D. Miser, J. B. Teeside, jr., and C. H. Dane in the Colorado Plateau region of northeastern Arizona, to collect data on early Mesozoic formations for the purpose of correlat-

ing some of these formations with those of the plateau region in adjoining States. A report on the investigations is in preparation. A report on iron ore on Canyon Creek, in the Fort Apache Indian Reservation, was prepared for the Indian Service by E. F. Burchard, who has also submitted a report on the same subject for publication in Contributions to economic geology. A report on the geology of the Camelsback dam site, Graham County, was made by Philip King for the Bureau of Reclamation. The chapter on the geology of Arizona to be embodied in the North American volume of *Geologie der Erde*, was completed by N. H. Darton.

ARKANSAS

A report on the geology and lead and zinc deposits of northern Arkansas, by E. T. McKnight, prepared under cooperative agreement with the Arkansas Geological Survey, is practically completed. Final completion awaits a brief visit to the region to settle some problems of stratigraphy and correlation. Progress was made by G. H. Girty in his study of the Morrow fauna of Arkansas and Oklahoma. A paper on deep wells that have reached basement rocks in the Coastal Plain in southwestern Arkansas, southeastern Oklahoma, and northeastern Texas was prepared by H. D. Miser and E. H. Sellards, for publication by the American Association of Petroleum Geologists.

Publication: Bulletin 808. (See p. 5.)

CALIFORNIA

Additional field work near Barnwell, Searchlight, Nipton, and Kelso was done by D. F. Hewett in connection with his study of the geology and ore deposits of the Ivanpah quadrangle. Some progress was made on the report by Adolph Knopf on the copper deposits of Plumas County. A paper by Professor Knopf on certain of the problems involved has been published in *Economic Geology*. F. E. Matthes resumed work on his report on the geomorphology of the upper San Joaquin Basin. Field and office studies of the San Andreas rift were continued by L. F. Noble, partly in cooperation with the Metropolitan Water District of Southern California. A brief report was prepared for the district to aid it in determining the geologically most favorable places to cross the San Andreas fault zone with proposed aqueducts from the Colorado River.

Work at the Lassen Volcano Observatory, at Mineral, in charge of R. H. Finch, consisted of continuous operation of seismographs at Mineral and Viola, observations of temperatures of the hot springs, measurements of movements in the land-slip areas, and studies of certain of the flows in Lassen Volcanic National Park.

Manuscripts for reports on the geology and oil resources of the Elk Hills, by W. P. Woodring, P. V. Roundy, and H. L. Farnsworth, and on the geology of the eastern part of the Santa Monica Mountains and adjacent areas, Los Angeles County, by H. W. Hoots, were transmitted for publication; also a paper on names and definitions of the geologic units of California, by M. Grace Wilmarth. The Devil's Postpile and its strange setting are described by F. E. Matthes in an article for the Bulletin of the Sierra Club of California and some peculiar fossil forms from California and Mexico by W. C. Mansfield in the Proceedings of the United States National Museum. W. P. Woodring submitted the following short papers for publication in scientific journals:

Tertiary deposits bordering the Simi Valley [abstract]. Proceedings of Cordilleran section of Geological Society of America.

Upper Eocene orbital Foraminifera from the Santa Ynez Range [abstract]. Proceedings of Cordilleran section of Geological Society of America.

Pliocene deposits north of Simi Valley.

Distribution and age of the marine Tertiary deposits of the Colorado Desert.

Publications: Professional Paper 158-I, Bulletin 812-D. (See pp. 4, 5.)

COLORADO

Cooperative work with the Geological Survey Board and the Metal Mining Board of the State of Colorado continued on an expanding scale under the general supervision of B. S. Butler. Mr. Butler and Q. D. Singewald continued the study of the Alma district, to be completed in 1931. With J. W. Vanderwilt Mr. Butler completed a study of the Climax district, which contains the largest molybdenum mine in the world. A preliminary report on the

istrict was transmitted in July, 1930, for publication by the Colorado Society. W. S. Burbank continued work in the Ouray-Telluride he San Juan region. Some of his preliminary results have just been by the Colorado Scientific Society in a paper entitled "Revision of gic structure and stratigraphy in the Ouray district of Colorado and g on ore deposition." E. B. Eckel was appointed junior geologist to : Burbank. T. S. Lovering completed his work on the Montezuma le and transmitted his final reports on that quadrangle and on the lge district. His paper on the geologic history of the Front Range, luct of the three years of work, has been published by the Colorado Society, and a preliminary paper on the mineral belt of the Front in press with the same society. Mr. Lovering began a study of the d tungsten district and examined several dam and reservoir sites in on with the Denver Water Commission and the Bureau of Reclama- N. Goddard, appointed junior geologist in June, is assisting Mr. in a study of the Jamestown district.

Behre continued work in the Iowa Gulch district and vicinity, south lle, and the more significant results were published in the Proceedings orado Scientific Society in a paper entitled "Revision of structure igrphy in the Mosquito Range and the Leadville district, Colorado," essentially a supplement to Professional Paper 148, on the geology and its of the Leadville district, and answers some of the questions raised eport. Mr. Behre also spent a short time in the Sugar Loaf and St. tricts, west of Leadville, to plan for a more thorough study later. ssance stratigraphic studies were made by H. D. Miser, J. B. Reeside, J. H. Dane in Sinbad Valley, Gateway, Paradox Valley, Gypsum Valley, le, Ouray, and Durango, and by Mr. Dane in western Mesa and Mon- inties in connection with studies on the stratigraphy and correlation rassic sandstones and associated formations of the Colorado Plateaus. on this subject including the plateau region of southwestern Colorado paration. Mr. Reeside prepared a paper on the Cretaceous faunas in on on Vermilion Creek, Moffat County, for publication in the Journal ashington Academy of Sciences. Edwin Kirk studied Devonian, Cam- d Ordovician sections near Ouray, Leadville, Aspen, Gilman, Glenwood and Colorado Springs. He continued the preparation of a paper on the stratigraphy of Colorado and nearly completed for outside publication on the Harding sandstone of Colorado.

al resources, structure, and stratigraphy of the eastern Yampa coal a the subject of a report in preparation by M. R. Campbell. Town- riptions of this field were completed by Mr. Campbell for the conser- anch. A comprehensive report on the geology of the entire San Juan being completed by E. S. Larsen, who contributed a short paper on nic history of the San Juan Mountains for publication by the Interna- odedic and Geophysical Union.

tions: Professional Paper 155; Bulletins 811-B, 812-C, 822-B. (See

CONNECTICUT

s. E. B. Knopf's work in New York.

FLORIDA

Mansfield completed a paper on pelecypods of the Choctawhatchee marl western Florida prepared in cooperation with the Florida Geological Part VI of The molluscan fauna of the Alum Bluff group of Florida, of the gastropod papers, was completed by Julia Gardner.

GEORGIA

work in the Coastal Plain of Georgia, primarily for the preparation ogic map of the State, was begun by C. W. Cooke, in cooperation with geological survey.

HAWAII

Hawaiian Islands the work on volcanologic research in charge of T. A. r., consisted of observations of Halemaumau, including mapping of n the pit, measurement from time to time of rim fissures, and measure-

ment of temperature stations at borings and at other points on the Kilauea floor; observations of Mauna Loa seismometrically and visually; operation of two 2-component seismographs and a newly set up vertical-component seismograph at the Kilauea station, a Japanese seismograph at the Uwekahuna Museum on the west cliff of Kilauea Crater, and 2-component seismographs under the direction of the observatory at Hilo and at Kealahou, maintained by the Hawaiian Volcano Research Association; measurements of seismograms from Hawaii, Kodiak, and Dutch Harbor; publication weekly of the Volcano Letter; preparation of the Monthly Bulletin; designing, building, and repairing instruments and making tests with oscillating table; recording tide data from the Hilo gage; directing the work of the Hawaiian Volcano Research Association, including direction of research associates and travel to Honolulu meetings; maintaining time service by wireless at Kilauea and at Kealahou.

In order that geologic surveys of the islands may be carried forward, Howard Powers, an assistant geologist, was appointed as assistant at the station. Mr. Powers made a reconnaissance of the island of Hawaii and began geologic mapping in Kona. He has also instituted systematic petrography as a part of the routine.

IDAHO

Field studies of the physiography and glacial geology of Fremont and Bonner Counties were continued by W. C. Alden, who also made progress on his report on the physiography of northern Idaho, eastern Washington, and western Montana. Partly in cooperation with the State, C. P. Ross made a reconnaissance of several small mining districts in south-central Idaho, and some of his results have been transmitted as short reports, part of which, on the geology and ore deposits of the Seafoam, Alder Creek, Little Smoky, and Willow Creek mining districts, have been published as mimeographed pamphlets by the Idaho Bureau of Mines and Geology. Another paper submitted for publication in *Economic Geology* is *Classification of the lode deposits of south-central Idaho*. A graphic history of metal mining in Idaho, by Mr. Ross, will be published by the Geological Survey in its *Contributions to economic geology*. Work in the Bayhorse quadrangle was continued by T. H. Hite, of the State Bureau, under Mr. Ross's direction. Cumulative results of Mr. Ross's work in Idaho are clarifying the hitherto obscure geologic features of one of the least-known regions in the Western States. Papers by G. R. Mansfield and C. P. Ross on old erosion surfaces in Idaho, discussions of a paper by A. L. Anderson on Cretaceous and Tertiary planation in northern Idaho, were submitted for publication in the *Journal of Geology*. Collections of Paleozoic and Tertiary invertebrates and Tertiary plants were identified by the paleontologists.

Publications: Professional Papers 158-F, 158-G; Bulletin 811-E. (See pp. 4, 5.)

ILLINOIS

W. W. Rubey completed field work and has made progress on the manuscript of a report on the Hardin and Brussels quadrangles, a cooperative project with the Illinois Geological Survey. The structural history of the Cap au Gres faulted flexure was described by Mr. Rubey in a paper for publication in the *Bulletin of the Geological Society of America*. David White continued his field and office studies in the cooperative project on the Pottsville flora of Illinois. He presented a paper on climatic implications of the Pennsylvanian flora for the quarter-centennial volume of the Illinois Geological Survey.

INDIANA

New species of Carboniferous invertebrates were described by G. H. Girty. Publication: Bulletin 811-C. (See p. 5.)

IOWA

An article on the pre-Illinoian Pleistocene geology of Iowa, by W. C. Alden, was prepared for publication in the *Journal of Geology*.

KANSAS

A cooperative field conference on work on the Cretaceous of Kansas was held at Beloit, by J. B. Reeside, jr., with K. K. Landes and R. C. Moore, of the Kansas Geological Survey.

KENTUCKY

from a deep well in west-central Kentucky were studied by E. O. Collections of lower and middle Eocene plants were studied by E. W.

ion: Professional Paper 156. (See p. 4.)

LOUISIANA

of the petrography of the gypsum anhydrite cap rock of the salt sulphur were continued by Marcus I. Goldman. A revised map of the fields of the State of Louisiana has been published. Cretaceous in- from deep wells were identified by T. W. Stanton for several oil

MARYLAND

relating to investigations by L. M. Prindle of dam sites in the Potosystem in Maryland were transmitted to the Corps of Engineers of

Detailed reports on Baltimore and Frederick Counties are being by A. I. Jonas for the Maryland Geological Survey, in informal with the United States Geological Survey. G. W. Stose did a little field work in connection with structural studies in Frederick and Counties, the results of which will probably be incorporated in the Hagerstown and Williamsport quadrangles.

MASSACHUSETTS

progress was made in the preparation of a report on the Taconic ling the Berlin and Greylock quadrangles, by L. M. Prindle. (See B. Knopf's work in New York.)

MICHIGAN

on: Professional Paper 154-A. (See p. 4.) (The area described is northern peninsula of Michigan.)

MINNESOTA

on: Professional Paper 154-A. (See p. 4.) (Describes that portion of western Minnesota that was covered by a readvance of the Superior Labrador ice sheet late in the Wisconsin stage of glaciation.)

MISSISSIPPI

ings from the Bourland well, at Amory, were studied by Charles P. V. Roundy.

MISSOURI

rich attended field conferences of the Missouri Geological Survey at several localities in the State in an effort to establish the sequence of the Proctor, and Van Buren formations. New species of Carboniferous invertebrates were described by G. H. Girty. Carboniferous invertebrates were described by P. V. Roundy.

MONTANA

of the coal beds, structure, and stratigraphy of portions of Custer and Counties were begun during the summer of 1929 and continued in June, 1930, by W. G. Pierce and party. A report on the geology and sources of the area is in preparation. A. J. Collier and party completed mapping of the areal and structural geology and coal beds of Blaine and Dawson Counties during the summer of 1929, and F. S. Parker extended this investigation to cover portions of Richland and Counties in June, 1930. A report on the geology of the Little Rocky and the surrounding plains is in preparation by Mr. Collier. W. T. continued field work in the Crow Indian Reservation, contributory to the geology and ground-water resources of Big Horn and the Crow Reservation. A report on the Ashland coal field, Powder River, and Custer Counties, by N. W. Bass, has been submitted to the Geological Survey.

A field study of the paleobotany of the Fort Union formation in eastern Montana was made by R. W. Brown. Cretaceous invertebrates were reported on by T. W. Stanton, and a report on Devonian invertebrates was made by Edwin Kirk for the Montana School of Mines. Further field work was done by W. C. Alden in parts of Sanders, Lake, Ravalli, and Beaverhead Counties, to gather additional data for his report on the glacial geology and physiography of portions of western Montana, northern Idaho, and eastern Washington. The study of the geology and mineral resources of the Libby quadrangle was continued by Russell Gibson. This work, begun as a Federal project in 1929, was continued in June, 1930, in cooperation with Lincoln County. The final report on the investigations of the greater Helena mining region by J. T. Pardee and F. C. Schrader is nearing completion. Mr. Pardee is also preparing a paper on late Tertiary faults in southwestern Montana.

Publications: Bulletins 811-A, 812-B. (See p. 5.)

NEBRASKA

Publication: Monograph 55. (See p. 4.)

NEVADA

Cooperation with the Nevada Bureau of Mines was established shortly before the beginning of the fiscal year, and under these auspices H. G. Ferguson resumed the study of mining districts in the Tonopah and Hawthorne quadrangles and the Tybo district, and T. B. Nolan began a resurvey of the Tonopah district. Developments at Tonopah have so greatly increased facilities for underground study since publication of the Geological Survey's report on the district in 1905 that much new light has been thrown on the complicated geologic problems. Mr. Nolan's preliminary report embodying these results was completed in June, 1930, for publication by the State Bureau of Mines. Further field studies were made by D. F. Hewett in portions of the Ivanpah quadrangle, and office work on his report on the geology and ore deposits of the quadrangle has progressed. Mr. Hewett also has in hand a report on examinations of manganese deposits in the vicinity of Las Vegas during 1929. The report by F. C. Schrader on the geology and ore deposits of the Carson Sink is nearing completion.

The report by Adolph Knopf and L. G. Westgate on the geology and ore deposits of the Pioche region was transmitted for publication as a professional paper. Edwin Kirk made a contribution to the Paleozoic stratigraphy of the region for incorporation in this report. Faulted fans west of the Sheep Range, southern Nevada, were described by C. R. Longwell in an article for the American Journal of Science.

Publication: Professional Paper 158-D. (See p. 4.)

NEW MEXICO

Field mapping of the coals of the Mesaverde formation of the southwestern edge of the San Juan Basin, in McKinley County, was continued by a party under the direction of J. D. Sears, and later by T. A. Hendricks, in 1929. Work to continue this mapping eastward and northward was resumed by Mr. Sears in 1930. Mr. Hendricks completed a manuscript on some details of sedimentation of the Mesaverde formation on the south side of the San Juan Basin for use as thesis material. A copy of this manuscript is in the open files of the geologic branch.

A reconnaissance survey of the Mesozoic stratigraphy in northwestern New Mexico was made by J. B. Reeside, Jr., who also studied Cretaceous invertebrates from the Gallup region and the San Juan Basin. R. W. Brown reported on collections of fossil plants from the Mesaverde formation of the Gallup-San Juan Basin. G. H. Girty reported on various collections of Carboniferous invertebrates and described the new species in them. A paper on the correlation of the Jurassic sandstones of the Colorado Plateau region, including northwestern New Mexico, is in preparation by A. A. Baker, J. B. Reeside, Jr., and C. H. Dane.

Informal cooperation with the New Mexico Bureau of Mines and Mineral Resources included continuation and extension of the work in the Magdalena mining district, begun some years ago by G. F. Loughlin. Field work in the district was completed, and substantial progress was made on the report.

1. Spencer continued preparation of his report on the geology and mineral resources of the Santa Rita district. The chapter on the geology of New Mexico for the volume on North America in *Geologie der Erde* has been completed by N. H. Darton. H. D. Miser and A. C. Spencer went to Carlsbad to serve on a board of review to consider a report by Kirk Bryan on the proposed enlargement of the Avalon Reservoir. The work on potash is described on pages 14-15.

NEW YORK

Mrs. E. B. Knopf continued detailed geologic mapping and petrographic studies of metamorphism of crystalline schists in the Clove and Millbrook quadrangles. She submitted a paper entitled "Retrogressive metamorphism and phyllonitization" to the American Journal of Science, setting forth some of the results of her studies. W. B. Lang visited the mine of the Sterling Salt Co. at Cuylerville and examined a core at the University of Rochester to determine whether it contained potash. Further field work in the Taconic region, which includes the Schoharie and Hoosick quadrangles, in New York, was done by L. M. Prindle, who continued office work on his report covering the whole Taconic region.

OHIO

Progress was made on studies of Devonian-Carboniferous faunas of Ohio by L. Girty.

OKLAHOMA

The fauna of the Sycamore limestone is described in a paper which G. H. Girty is preparing in collaboration with Mr. Cooper, of the Oklahoma Geological Survey. Mr. Girty is also preparing papers on the Morrow and the Moorefield limestones. P. V. Roundy is preparing a paper on the ostracodes and conodonts of the Sycamore limestone, and Edwin Kirk studied crinoids from this same formation. E. O. Ulrich studied the Tyner and Burgen formations in central eastern Oklahoma, studied and reported on fossil invertebrates from the Ardmore formation, and made a field study of that formation in the Arbuckle Mountains in cooperation with members of the Oklahoma Geological Survey. The sale of Osage leases at Pawhuska was attended by Mr. Roundy to advise the Indian Service concerning the adequacy of bids. A paper on deep wells that have reached basement rocks in the Coastal Plain in southeastern Oklahoma and adjoining areas was prepared by H. D. Miser and E. H. Sellards for the American Association of Petroleum Geologists.

OREGON

Work in cooperation with the Oregon State Mining Board, begun in June, 1930, continued throughout the year, with greatly increased scope in June, 1930. T. Pardee made preliminary examinations of several mining districts in eastern Oregon, and his report on the status of the industry has been released in mimeographed form. In June three parties under his direction were making detailed studies—A. F. Buddington and Eugene Callaghan in the Bohemia gold district, F. G. Wells and A. C. Waters in the Black Butte quicksilver district, and P. J. Shenon with assistants in the Takilma copper district. Mr. Pardee continued examination of mineral deposits in outlying districts and has cooperated with the State Highway Department in a study of road materials. In eastern Oregon D. F. Hewett examined accessible mines in the Sumpter quadrangle, to supplement data collected in 1914, and his paper on the present economic outlook of ore deposits in the quadrangle was completed soon after the end of the fiscal year. James Gilluly made a detailed study of the copper deposits that were the scene of considerable recent activity near Keating, in the Baker quadrangle, and less detailed studies of other districts in the Sumpter quadrangle. His preliminary report on the deposits near Keating has been issued in mimeographed form, and his final report is practically complete. In June Mr. Gilluly resumed work in the region with J. C. Reed, junior geologist.

Messrs. Pardee and Gilluly also examined several dam sites along the Umpqua River for the War Department.

PENNSYLVANIA

In cooperation with the Pennsylvania Geological Survey investigations were continued by G. W. Stose on the Martinsburg shale, Delaware Water Gap quadrangle, and on the geology and mineral resources of the Hanover, York, Middletown, and Lancaster quadrangles, the reports on which will be published by the State organization. The manuscript for the geologic map of Pennsylvania to be published by the State Survey has been completed. Detailed reports on the geology and economic resources of the following quadrangles are in course of preparation for publication by the Federal Survey: Honeybrook and Phoenixville, by G. W. Stose; Butler and Zelienople, by G. B. Richardson; Tyrone, by Charles Butts. A paper on the unconformity at the base of the Medina sandstone in southeastern Pennsylvania was prepared by Mr. Stose for the Geological Society of America, and one on the gravel and peneplains of Pennsylvania for the Geological Society of Washington.

Devonian and Carboniferous invertebrates of the Bradford quadrangle were reported on by Mr. Butts. Paleozoic invertebrate collections obtained in eastern Pennsylvania by Mr. Stose were identified by E. O. Ulrich.

Publications: Bulletin 799, Folio 225. (See pp. 5, 6.)

SOUTH CAROLINA

A comprehensive report on the geology of the Coastal Plain of South Carolina is in preparation by C. W. Cooke.

SOUTH DAKOTA

D. F. Hewett examined manganese deposits at Chamberlain and prepared a brief report thereon entitled "Manganese-iron carbonate nodules in the Pierre shale near Chamberlain, S. Dak."

Publication: Monograph 55. (See p. 4.)

TENNESSEE

The Cretaceous and Tertiary formations of western Tennessee were examined in the field by L. W. Stephenson in informal cooperation with the Tennessee Geological Survey, in connection with a report on the Foraminifera to be prepared by I. G. Reimann for the State Geological Survey.

Publication: Professional Paper 156. (See p. 4.)

TEXAS

Field studies in Uvalde, Zavala, and Dimmit Counties, in cooperation with the water-resources branch in tracing the source of the water supply for the Winter Garden area, were made by L. W. Stephenson and Julia Gardner. Mr. Stephenson continued preparation of his monograph on the fossils of the Navarro formation of Texas. This work, which will require some additional field studies, is being done in cooperation with the Texas Bureau of Economic Geology, and the report will be issued as a publication of that bureau. Papers by Mr. Stephenson entitled "Unconformities in the Upper Cretaceous series of Texas" and "Two new mollusks of the genera *Ostrea* and *Æogyra* from the Austin chalk of Texas" were published in outside journals. Miss Gardner continued field work on the Eocene of southwestern Texas, which was supplemented by field work in Denmark and England and study of collections in museums of England, France, and Germany, for the purpose of establishing the Eocene age of the Midway formation.

Field and office work on the revised geologic map of the State was continued by N. H. Darton, who examined previously unmapped areas in the western and central parts of the State. He has prepared topographic base maps for many of the quadrangles in southwestern Texas. The geologic map of the Coastal Plain of Texas to be included in the new map of the State will incorporate, in addition to results of field investigations by Mr. Stephenson and Miss Gardner, data obtained from oil companies and other sources. Field studies of the geology of the Marathon Basin were continued by Philip King. This work is also partially contributory to the revised geologic map of the State.

A revised map of the oil and gas fields of Texas is in preparation. A paper by H. D. Miser and E. H. Sellards on deep wells that have reached basement rocks in the Coastal Plain of northeastern Texas was prepared for publication by the American Association of Petroleum Geologists.

Work on potash is described on pages 14-15.

UTAH

Detailed structural and stratigraphic studies in the Green River Desert and adjoining portions of the San Rafael Swell not previously mapped were begun in June, by A. A. Baker. A geologic report with special reference to stratigraphy and structure of the Monument Valley-Navajo Mountain district of the southern San Juan area is in preparation by Mr. Baker, who also completed his report on the geology and oil possibilities of the southeastern part of the Moab district, Grand and San Juan Counties. C. H. Dane carried on plane-table mapping and structural and stratigraphic studies in Grand County, a continuation of work begun in 1929. His report on the geology and oil possibilities of the Salt Valley area, Grand County, is being prepared.

The Book Cliffs coal field has been studied by D. J. Fisher, who has completed and transmitted a report on the general geology of the Book Cliffs southeast of Sunnyside and an economic contribution on the Book Cliffs coal field. Studies of the coals, stratigraphy, and structure of portions of the Wasatch Plateau are being continued by E. M. Spieker. The work is done primarily for the purpose of classifying the public lands as to coal resources, but reports descriptive of the scientific and economic results will also be prepared. A paper on the structure of the Manti-Salina area was submitted by Mr. Spieker for publication in the Bulletin of the Geological Society of America. A report on the correlation of the Jurassic sandstones and associated formations of the Colorado Plateaus, including southeastern Utah, is in preparation by A. A. Baker, J. B. Reeside, jr., and C. H. Dane. Early Paleozoic sections near Salt Lake City and Brigham City were studied by Edwin Kirk. T. B. Nolan continued office work on his report on the geology and mineral resources of the Gold Hill quadrangle. A paper on Paleozoic formations in this quadrangle was submitted for publication in the Journal of the Washington Academy of Sciences.

Publication: Professional Paper 158-E. (See p. 4.)

VERMONT

L. M. Prindle made a geologic reconnaissance trip through the Green Mountain Purchase area for the Forest Service in connection with a proposed national forest in this area. He also studied a part of the Taconic area, which includes the Bennington quadrangle, in southwestern Vermont. Mrs. E. B. Knopf made a short trip to northern Vermont and an adjoining section of Canada to study some of the schists and fault phenomena in the Green Mountains and their possible relations to similar phenomena in the Clove and Millbrook quadrangles, New York.

VIRGINIA

Charles Butts continued his field and office work in the Appalachian Valley, in cooperation with the Geological Survey of Virginia. The results of the investigations will be used in the revision of the geologic map of the State. The field work, a northward extension of that done during previous years, included portions of Craig, Roanoke, Montgomery, Botetourt, Alleghany, Rockbridge, and Augusta Counties. Special problems in stratigraphy and paleontology of this region were studied by E. O. Ulrich in company with Mr. Butts. The gravel deposits of Virginia were studied by M. R. Campbell in cooperation with the Virginia Geological Survey. L. M. Prindle examined the geology of certain dam and reservoir sites in the Valley of Virginia, for the Corps of Engineers.

A paper on silicified bog-iron deposits and associated silicified rocks at the contact between the Cambrian and Ozarkian (basal Ordovician), in Virginia, by M. I. Goldman, was published in Germany in a Festschrift in honor of Prof. Johannes Walther on the occasion of his seventieth birthday.

Publication: Professional Paper 158-C. (See p. 4.)

WASHINGTON

Field studies of the physiography and glacial geology of Chelan, Douglas, Grant, Lincoln, Okanogan, Ferry, Stevens, and Spokane Counties were continued by W. C. Alden, who also made progress on his report on the physiography of northern Idaho, eastern Washington, and western Montana. A paper on Columbia River terraces by Mr. Alden was delivered before the Geological Society of Washington. J. T. Pardee examined deposits of manganese on the Dosewallips River at Lake Crescent.

WEST VIRGINIA

Reports relating to investigations by L. M. Prindle of dam sites in the Potomac River system in West Virginia were transmitted to the Corps of Engineers.

T. A. Hendricks sampled coals from the Pocahontas coal fields for the use of the Bureau of Mines in a series of tests on the friability of coal.

Publication: Professional Paper 158-C. (See p. 4.)

WISCONSIN

W. C. Alden engaged in a field conference and the examination of glacial deposits in the northwestern counties of Wisconsin with E. F. Bean, State geologist.

Publication: Professional Paper 154-A. (Describes parts of northern Wisconsin that were covered by a readvance of the Superior lode of the Labrador ice sheet late in the Wisconsin state of glaciation.)

WYOMING

The origin and geologic history of the Tertiary rocks of the Green River Basin are being studied by W. H. Bradley, whose report on past investigations is well under way. Mr. Bradley made reports on the Alcova and Seminoe dam sites for the Bureau of Reclamation. J. B. Reeside, Jr., and A. A. Weymouth completed a paper on mollusks from the Aspen shale (Cretaceous) of southwestern Wyoming, for publication in the Proceedings of the United States National Museum. A revised map of the oil and gas fields of Wyoming has been completed. The chapters on the Big Horn and Owl Creek Mountains, Wyoming and Montana, for incorporation in the volume on North America in *Geologie der Erde*, were completed by N. H. Darton.

Publications: Monograph 55; Professional Papers 158-E, 158-H, 165-A, 165-B; Bulletin 811-D. (See pp. 4, 5.)

MISSISSIPPI VALLEY

A detailed study of the geomorphology of the head of the Mississippi embayment was begun by F. E. Matthes as a part of a general study of the development of the lower Mississippi River. An understanding of the changes in the course of the river during its development and of the reasons for its present relations to the valley and to such physical features as Crowley's Ridge can hardly fail to be of importance in the consideration of any broad plan for river rectification or control.

BRAZIL

David White studied Mesozoic and Tertiary plants from the Geological Survey of Brazil.

VENEZUELA

A paper on the Pao deposits of iron ore in the State of Bolivar, Venezuela, was presented by E. F. Burchard at the meeting of the American Institute of Mining and Metallurgical Engineers in New York in February and was published by that organization as Technical Publication 295.

GENERAL INVESTIGATIONS

Investigations covering broad fields of geologic research or areas not confined to individual States are in progress by many of the geologists, and reports are in preparation on the following subjects:

Geology of the Rocky Mountains and northern plateau region, for *Geologie der Erde*, by J. B. Reeside, jr.; geology of the east-central United States, for *Geologie der Erde*, by Charles Butts; geology of the Great Basin, by D. F. Hewett; igneous rocks of the Great Basin, by James Gilluly; copper deposits of the southern Appalachian region, by C. S. Ross and M. N. Short; origin of chromite, by C. S. Ross; antimony deposits of the world, by F. C. Schrader; new estimates of the coal reserves of the United States, by M. R. Campbell; intercycle interpolation of plates in Crinoidea, by Edwin Kirk; genus *Marginifera*, by G. H. Girty; genus *Productus*, by G. H. Girty; early Paleozoic cephalopods, by E. O. Ulrich and A. F. Foerste. Other investigations in progress are studies of stratigraphy and paleontology of the Appalachian Valley and of the Upper Cambrian trilobites of the family Telephidae, by E. O. Ulrich; Foraminifera of the Coastal Plain, by J. A. Cushman; micro-fossils, by P. V. Roundy; Cretaceous formations of the Western Interior province, by J. B. Reeside, jr.; and paragenesis of ore minerals, by M. N. Short.

Cooperative investigations with other organizations included work of David White and others in connection with committees of the National Research Council and the National Academy of Sciences.

The following papers giving the results of some of these studies were completed during the year and submitted for publication as professional papers or bulletins of the United States Geological Survey or through unofficial channels.

The kaolin minerals, by C. S. Ross and Paul F. Kerr. Shorter Contributions to General Geology. Abstract in Journal of the American Ceramic Society.

The Upper Cretaceous ammonite genus *Barroisiceras* in the United States, by J. B. Reeside, jr. Shorter Contributions to General Geology.

Microscopic determination of ore minerals, by M. N. Short. Bulletin of the United States Geological Survey.

Map of oil and gas fields of the United States.

Violarite and other rare nickel minerals, by M. N. Short and E. V. Shannon. American Mineralogist.

Occurrence and relations of alabandite, by D. F. Hewett and Olaf N. Rove. Economic Geology.

New Carboniferous invertebrates, II, by G. H. Girty. Journal of the Washington Academy of Sciences.

Dickite, a kaolin mineral, by C. S. Ross and Paul F. Kerr. American Mineralogist.

Correlation of Pleistocene coastal terraces, by C. Wythe Cooke. Journal of Geology.

Trophocrinus, a new Carboniferous crinoid genus, by Edwin Kirk.

The behavior of certain mud-crack casts during compaction, by W. H. Bradley. American Journal of Science.

Pleistocene seashores, by C. Wythe Cooke. Journal of the Washington Academy of Sciences.

Chromium, by W. D. Johnston, jr. Mineral Industry.

The incipient stages of rock metamorphism as recorded in coal, by M. R. Campbell. Economic Geology.

Stratigraphic names, by T. W. Stanton. Bulletin of the American Association of Petroleum Geologists.

Natural groups of coal and allied fuels, by M. R. Campbell. American Institute of Mining and Metallurgical Engineers.

A Cretaceous pelecypod with color markings, by J. B. Reeside, jr. Journal of the Washington Academy of Sciences.

Note on temperature gradients in the Permian Basin, by W. B. Lang. Journal of the Washington Academy of Sciences.

Outline of a suggested classification of coals, by David White. American Institute of Mining and Metallurgical Engineers.

Summary of nitrate deposits in the United States, by G. R. Mansfield, for presentation at meeting of Society of Economic Geologists.

WORK IN CHEMISTRY AND PHYSICS

E. P. Henderson resigned during the year to become assistant curator of the National Museum. His work was carried on temporarily by J. C. Reed and F. S. Parker, geologists, but they were later assigned to field work. At the end of the year R. C. Wells was designated chief chemist, thus relieving George Steiger, who will devote his time to research work.

The work in chemistry and physics includes tests necessary to the determination of rocks, ores, and minerals collected or received by the Geological Survey, qualitative and quantitative chemical analyses of specimens and samples collected by geologists, and researches relating to the problems in geology on which the Geological Survey is engaged.

During the year 363 samples were analyzed to furnish information in connection with studies being made by members of the Geological Survey and 2,900 specimens were identified for other persons. In addition 6,500 samples of cores and cuttings from 112 wells in Texas and New Mexico were analyzed or otherwise tested in connection with the exploration for potash. Petrographic examinations of the cores were made by W. T. Schaller, E. P. Henderson, J. J. Fahey, and F. C. Calkins, and chemical determinations principally by Mr. Fahey and E. T. Erickson. R. K. Bailey, stationed at Roswell, N. Mex., prepared logs of the well cores, made preliminary tests, and selected material for shipment to Washington for analysis.

J. G. Fairchild, who made most of the quantitative analyses of rocks during the year, also studied the reducing power of pyrite as measured by the nitrogen oxides evolved when it is heated with nitric acid. The diffusion of mixtures of gases through very small passages in rocks was studied by R. C. Wells for the purpose of explaining the origin of different natural gases. He also determined the solubility of some rare-earth nitrates in ether at ordinary temperatures.

Six days of field work was spent by W. T. Schaller in examining the soda pegmatites of the Maryland-Pennsylvania State line and a deposit of beryl in Maine. He also read several manuscripts critically, analyzed psittacinite from Arizona, studied the natural ammonium borates, among which a new species was identified, and prepared manuscript for a series of mineralogical notes covering the following subjects: Ptilolite from Utah; the mordenite-ptilolite group; clinoptilolite, a new species; hydrozincite from Nevada; tephroite from New Jersey; ludlamite from New Mexico; the ludwigite group; argentojarosite and associated secondary minerals from Utah.

Most of the time of George Steiger was devoted to administrative work. In collaboration with C. S. Ross he continued his studies of the function of water in the highly hydrated clay minerals. He also studied the chemical composition of the insoluble residue, other

than carbonate, in Indiana limestone and prepared a bibliography of chemical investigations relating to sedimentation for the National Research Council committee on that subject.

The science of radioactivity has in recent years contributed to geologic knowledge in several fundamental ways. It has offered geologists a new source of heat in the earth and a means of determining the age of certain minerals. Each of these subjects received attention from Geological Survey scientists the past year. C. E. Van Orstrand measured the temperature gradient in certain bore holes, and Mr. Wells analyzed some samarskites and uraninites for lead, uranium, and thorium, thus enabling the age of these minerals to be calculated. In addition, in conjunction with a determination of the atomic weight of the lead made by Prof. G. P. Baxter, of Harvard University, the results afford a means of determining the rate of disintegration of thorium during a very long period of time. These investigations have been urged and supported by Dr. A. C. Lane, chairman of the National Research Council committee on the determination of geologic time.

The investigations relative to potash, to which a large part of the time of the chemists was given, have consisted almost entirely in determining the percentage of potassium present and in identifying the minerals. Little has been done in explaining the conditions of formation of the minerals, but in a broad way it is clear that many chloride and sulphate minerals of potassium, resembling those of the German salt deposits, are present over an extensive area in New Mexico and western Texas. The progress of the year extends and confirms the findings recorded in last year's report.

In addition to attending to the usual administrative duties of the physical laboratory, Mr. Van Orstrand supervised investigations on geothermal gradients that are being conducted in Texas, Oklahoma, and California by the American Petroleum Institute, and in December, at the request of officials of that institute, he assumed the directorship of its project No. 26, an investigation that is being conducted in the physical laboratory of the Geological Survey by F. C. Weaver on a thermal conductivity method of gas analysis. Temperature tests were made in deep wells at Roswell, N. Mex.; Long Beach, Calif.; Thermopolis, Wyo.; Garnet, Kans.; and Florence, Kans. Considerable time was given to theoretical investigations on the flow and transfer of heat in the crust of the earth.

Laboratory methods and apparatus for finding the densities, porosities, and permeabilities of oil sands were further developed by P. G. Nutting and used in determining the properties of a great many oil sands from different localities. The results of some of these analyses have led to improvements in oil recovery in some fields. The study of adsorbing surfaces on silica and different silicates was continued, in particular their preparation and behavior toward water, petroleum, tar, and other substances. Many filtering clays were examined and tested. Further studies were made of the retention of moisture by clays under different conditions of humidity and temperature.

The following papers were completed during the year:

- Fairchild, J. G., The volumetric determination of fluorine by the use of ferric chloride: Washington Acad. Sci. Jour., vol. 20, Apr. 19, 1930.
- Nutting, P. G., The laws of distribution of particles in suspension: Science, new ser., vol. 70, p. 409, Oct. 25, 1929.
- The stratified settling of fine sediments: Washington Acad. Sci. Jour., vol. 19, pp. 402-406, 1929.
- Some physical problems in oil recovery: Oil and Gas Jour., Nov. 21, 1929, p. 44.
- Adsorption and emulsion formation: Science, new ser., vol. 71, pp. 36-37, Jan. 10, 1930.
- Vapor pressure and heat of vaporization: Ind. and Eng. Chemistry (in press).
- The physical analysis of oil sands: Am. Assoc. Petroleum Geologists Bull. (in press).
- Schaller, W. T., Crystal cavities in the New Jersey zeolite region (to appear as a bulletin of the Geological Survey).
- and Henderson, E. P., Mineralogy of the drill cores from the New Mexico-Texas field (to appear as a bulletin of the Geological Survey).
- Stelger, George, Investigations of chemistry that have a bearing on problems of sedimentation (to appear in annual report of committee on sedimentation, National Research Council).
- Van Orstrand, C. E., Description of apparatus for the measurement of temperatures on deep wells; also some suggestions in regard to the operation of the apparatus, and methods of reduction and variation of the observations (to be published by the American Petroleum Institute).
- Wells, R. C., Origin of helium-rich natural gas: Washington Acad. Sci. Jour., vol. 19, Sept. 19, 1929.
- and Hess, F. L., Samarskite from Petaca, N. Mex.: Washington Acad. Sci. Jour., vol. 19, January, 1930.
- The solubility of some rare-earth nitrates in ether: Washington Acad. Sci. Jour., vol. 20, Apr. 19, 1930.
- Uraninite from Placer de Guadalupe, Chihuahua (to be published in American Mineralogist).

ALASKAN BRANCH

PHILIP S. SMITH, Chief Alaskan Geologist

ORGANIZATION AND PERSONNEL

The Alaskan branch consists of the chief Alaskan geologist, 3 geologists, 1 mining engineer, 1 coal-mining assistant, 2 topographic engineers, 1 draftsman, 4 clerks, and 1 minor apprentice lithographer. John B. Torbert, who had for many years done the greater part of the expert map drafting for the branch, died during the year.

SCOPE OF THE WORK

The task of obtaining information regarding the mineral resources of Alaska and assisting the industry in every practicable way has for many years devolved upon the Alaskan branch. In the third of a century that this work has been in progress the Geological Survey has published several hundred reports on various phases of the mineral industry of Alaska, and these have been accompanied by several hundred maps of different parts of the Territory. Practically every known mineral-producing camp has been visited by the geologists, engineers, and topographers of the Geological Survey, and reports regarding these camps have been issued. There still remain, however, extensive tracts of Alaska that have not yet been surveyed, though some of them are believed to hold promise.

of containing mineral deposits that may be of value. In fact, although more than 40 per cent of the Territory has been surveyed, at least on exploratory standards, there is probably an area of more than 200,000 square miles that is regarded as of potential mineral value which should be studied as soon as funds and personnel can be assigned to the work. This is a conservative estimate and would exclude more than 100,000 square miles of country, such as the Yukon Delta and Yukon Flats, where, though there may be deposits of value, the services that can be rendered by geologists in a preliminary search would not be great enough to warrant much work until studies in other more promising areas have been completed.

Furthermore, it should be evident that the exploratory and reconnaissance standards that have been adopted for practically all the work so far accomplished in Alaska are adequate to give only general information, so that detailed investigations, such as are essential to the solution of most mining problems, are required for higher standards of work. The task of making a thorough inventory of the mineral resources of Alaska is a large one, on which only a start has yet been made.

FUNDS

The funds used by the Geological Survey in its Alaska work are provided in two items in the general act making appropriations for the Interior Department. One of these is "for continuation of the investigation of the mineral resources of Alaska." In the act for the fiscal year 1930 the amount appropriated was \$67,500. In the similar act for 1931 the amount appropriated was \$75,000. Each of these appropriations was made available immediately on the passage of the act in which it was contained. The other item is an allotment made from the appropriation "for the enforcement of the provisions of the acts of October 30, 1914, October 2, 1917, February 25, 1920, and March 4, 1921, and other acts relating to the mining and recovery of minerals on Indian and public lands and naval petroleum reserves." Allotments under this item are available only during the fiscal year specified. In each of the fiscal years 1929 and 1930 an allotment of \$10,000 was made for work of this kind in Alaska. The two types of work indicated will be described for convenience as the work on mineral resources and the leasing work.

WORK ON MINERAL RESOURCES

PRINCIPAL RESULTS OF THE YEAR

The principal products of the Alaska work of the Geological Survey are reports and maps based on original surveys or investigations. During the year 21 such official reports have been issued or have been completed by their authors and approved for publication, as follows:

- The Chandalar-Sheenjek district, by J. B. Mertie, jr. (Bulletin 810-B).
- The Mount Spurr region, by S. R. Capps (Bulletin 810-C).
- The mineral industry of Alaska in 1928, by Phillip S. Smith (Bulletin 813-A).
- Administrative report, fiscal year 1929, by Phillip S. Smith (Bulletin 813-A).
- The Chakachamna-Stony region, by S. R. Capps (Bulletin 813-B).
- Mining in the Fortymile district, by J. B. Mertie, jr. (Bulletin 813-C).

Notes on the geology of upper Nizina River, by F. H. Moffit (Bulletin 813-D).

Mineral resources of Alaska: Report on progress of investigations in 1928, by Philip S. Smith and others (Bulletin 797).

Mineral resources of Alaska: Report on progress of investigations in 1927, by Philip S. Smith and others (Bulletin 810).

Geology and mineral deposits of southeastern Alaska, by A. F. Buddington and Theodore Chapin (Bulletin 800).

Geology of the Eagle-Circle district, Alaska, by J. B. Mertie, jr. (Bulletin 818).

Geography and geology of northwestern Alaska, by Philip S. Smith and J. B. Mertie, jr. (Bulletin 815).

Mineral industry of Alaska in 1929, by Philip S. Smith (Bulletin 824-A).

Administrative report, fiscal year 1930, by Philip S. Smith (Bulletin 824-A).

Phototopographic work in southeastern Alaska in 1929, by R. H. Sargent.

The occurrence of gypsum at Iyoukeen Cove, Chichagof Island, by B. D. Stewart.

The Slana district, upper Copper River region, by F. H. Moffit.

The Lake Clark-Mulchatna region, by S. R. Capps.

Recent mining developments in the vicinity of Circle, by J. B. Mertie, jr.

The Upper Cretaceous floras of Alaska, by Arthur Hollick, with a description of the Upper Cretaceous plant-bearing beds, by G. C. Martin (Professional Paper 159).

Glaciation in Alaska, by S. R. Capps.

Six short papers on the mineral production of Alaska and various phases of the work of the Alaskan branch were published as press bulletins.

Practically all the completed reports are accompanied by maps, the bases of which have been made principally from surveys conducted by the topographers of the Alaskan branch. The following maps have been published during the year:

Topographic map of Valdez and vicinity, by J. W. Bagley, C. E. Giffin, and R. H. Sargent; scale, 1:62,500. Published for sale.

Topographic map of Revillagigedo Island, by R. H. Sargent; scale 1:250,000. Compiled principally from aerial photographs taken by the Alaska Aerial Survey Expedition of the Navy Department, 1926. Issued in a preliminary photolithographic edition.

Map of Alaska; scale, 1:5,000,000. Containing index of Alaska maps and list of Alaska publications.

Topographic map of Goodnews Bay district, by R. H. Sargent and W. S. Post; scale, 1:250,000. Issued in a preliminary photolithographic edition.

Progress was also made in the preparation of a map of the Mount Spurr region and a map of the Lake Clark-Mulchatna region, scale 1:250,000, compiled from surveys in recent years in the Skwentna, Mount Spurr, Chakachamna-Stony, and Lake Clark-Mulchatna districts. Considerable work has also been done in compiling the results of recent surveys on a topographic map of the Yukon-Tanana region, scale 1:500,000, which has been in progress for several years, and in the revision of the map of Alaska on a scale of 1:2,500,000, with a view to the publication of a new edition for sale. The small general map of Alaska on a scale of about 80 miles to the inch is kept currently revised and reissued as frequently as required.

Besides the official reports, several articles were prepared by the scientific and technical members of the Alaskan branch for publication in outside journals, and 26 public lectures were given regarding the general work of the branch or some of its special features. Most of these were prepared unofficially but represent by-products of the regular work and serve to reach special audiences not readily reached by the official publications. Among the published articles may be mentioned the following:

Mountain building in Alaska, by J. B. Mertie, jr.; delivered before the Geological Society of Washington.

Alaska gold resources, by Philip S. Smith; published in *Economic Geology*. Scientific work of the United States Geological Survey in Alaska in 1929, by Philip S. Smith; published in *Journal of the Washington Academy of Science*.

A new species of Tertiary cycads, by Arthur Hollick; for publication in *Memoirs of the New York Botanical Garden*.

Molybdenite deposit at Shakan, Alaska, by A. F. Buddington; for publication in *Economic Geology*.

Aerial photographing in southeastern Alaska, by R. H. Sargent; delivered at meeting of Association of American Geographers.

A study of the results of ice flow as shown in oblique and vertical photographs taken of glaciers in Alaska by R. H. Sargent; delivered at meeting of Association of American Geographers.

Photographing Alaska from the air, by R. H. Sargent; published in *Military Engineer*.

Glaciation in Alaska, by S. R. Capps; presidential address delivered before Geological Society of Washington.

Albert Perry Brigham, geologist, by Philip S. Smith; published in *Annals of Association of American Geographers*.

PROJECTS IN PROGRESS DURING THE SEASON OF 1929

The work done by the Geological Survey in connection with the study of Alaska is so diverse that it can not be reduced to common terms capable of unified tabulation or coordinated description. It embraces areal surveys that are readily definable in terms of square miles mapped, examinations in mining camps that cover only small tracts and yet require the outlay of much time and effort, and laboratory researches or office studies that exceed the scope of the original field investigations. The most comprehensive idea of the work of the Alaskan branch in 1929 may therefore be gained from descriptions of the projects undertaken.

In addition to the routine duties of supplying information to hundreds of inquiries received from the public and from other branches of the Government, the work of the branch consisted of seven principal projects, as set forth below.

Topographic supervision of aerial photographic work in southeastern Alaska as a continuation of a project started in 1926, when the Navy Department, at the request of the Geological Survey, photographed from the air about 10,000 square miles of southeastern Alaska, so that the resulting pictures might be used for preparing maps of the region. This work was so successful and of such inestimable value, not only to the Geological Survey but also to other Government bureaus, notably the Forest Service, that in the winter of 1928-29 the Geological Survey joined with the Forest Service in requesting the Navy Department to send another expedition to continue the work in tracts that had not been photographed. The Navy Department, recognizing the need of these bureaus and the excellent training that the work afforded for its own members, assigned the necessary personnel and equipment, under command of Lieut. Commander A. W. Radford. This unit photographed about 12,000 square miles of difficult country with speed, precision, and high technical competence, and the resulting films were turned over to the Geological Survey for cartographic use. In the course of this work many services were rendered to other Government bureaus concerned with Alaskan development. The successful accomplishment of this difficult piece of work without accident demonstrates the great value of the airplane as a means of transportation in a country that is almost untraversable by any other means and shows the economy that can be effected in many phases of the Geological Survey's work by this modern method of attack. In order that the naval officers might have knowledge of the requirements, a skilled topographic engineer of the Alaskan branch, R. H. Sargent, was attached to the expedition and served throughout its field work.

The turning over of the developed films ended the Navy Department's share of the work, but many steps must be taken before the data thus obtained are worked up into maps. As both the Geological Survey and the Forest Service required a print of each picture it was necessary to make nearly 50,000 separate prints—a task that occupied three men for about six months. This was a surprisingly good record, for two-thirds of the films required special manipulation to take out certain inclinations caused by the particular type of camera used, and all the work had to be done with close mathematical adjustments as well as photographic skill. This phase of the work was completed near the end of the fiscal year. The next step will be the mounting of these prints, most of which are assembled in groups of three on specially prepared cards. The prints must be accurately trimmed and mounted so that certain identifying marks on them will be brought into exact accord with other marks printed on the cards. This is a precise, time-consuming job that is estimated will take the equivalent of one man's time for a full year. From these mounted prints must then be taken the desired cartographic data, which will be compiled on a working sheet and supplemented by names and data from other sources to form a drainage map. This map will then be sent into the field to serve a topographer as a base on which to determine the altitude of all the natural features and represent them by means of contours. It is estimated that it will take more than 20 years before the area photographed in the two Navy Department expeditions will be worked up to this final stage if the current rate of progress is maintained. Obviously the rate should be much accelerated, but greater speed is impossible without additional funds.

A geologic reconnaissance of parts of the area lying near the headwaters of the Copper River and extending over into the drainage basin of the Tok River and its tributaries, north of the Alaska Range, was carried on by F. H. Moffit. This region was mapped topographically in 1902 on the exploratory standards of that day, and some geologic exploration was carried on at the same time. The geologic results were never published in full, however, and the great amount of geologic information that has been collected from near-by regions since that work was done raised many questions that could be answered only by a thorough field review and extension of the earlier observations. The region is one of direct and indirect importance in the search for workable mineral deposits in Alaska. It is of direct importance because it lies adjacent to areas that have long been known to be mineralized and to afford evidence of the presence of gold and lead and some indications of the presence of copper. Indirectly the area is of great geologic significance because it lies athwart the Alaska Range, and consequently the correct interpretation of its geologic history will throw light on the general history of the mountain building and related processes that were doubtless more or less closely connected with the mineralization of parts of Alaska. The tracing of the geologic sequence of events from the Copper River region on the south side of the mountains to the Tanana and Yukon Valleys on the north will greatly strengthen and supplement the information obtained from either district alone.

Combined geologic and topographic reconnaissance surveys in the Lake Clark-Mulchatna region were conducted by S. R. Capps, geologist, and Gerald Fitzgerald, topographer. This party mapped more than 1,300 square miles of hitherto unsurveyed country and completed the work of blocking out the major features of an immense tract of the Alaska Range. The geologic results obtained show that this part of the range consists primarily of a great granitic intrusive mass which is flanked on the west by sediments and extrusive igneous rocks. Little prospecting has been done in the region, though placer gold has been recognized in some of the stream valleys and the presence of the great intrusive mass cutting a variety of other rocks offers some hope that lodes of value may be found in the vicinity of the contacts.

Geologic reconnaissance work was continued in the Yukon-Tanana region as part of the general project of coordinating the many observations that have been made in that region in the last 30 years and studying with more care certain tracts that had been passed by in the earlier surveys or given only cursory examination. The particular part of this large tract that was examined for this purpose in 1929 lies north of Fairbanks and west of Circle. This work was done by J. B. Mertie, Jr., who revised or completed the mapping of the geology of about 1,500 square miles of country and visited almost all the producing placer camps in the Circle district. This season's work completes the field work on the major project of revising the geology of the tract lying between the Yukon and Tanana Rivers, but the office studies and preparation of a report and the maps to accompany it will require much additional time.

and effort. The results of this critical study should be of much significance in explaining the general geologic history of the region and the conditions under which the mineralization was effected.

The collection of information regarding the output of minerals from Alaska was carried on as usual. The annual production reports are compiled on the basis of the calendar year, but the work of canvassing the producers and assembling the data is practically continuous.

The Geological Survey maintains in Alaska two district offices, one at Juneau and one at Anchorage. The main duties of the personnel attached to these offices relate to mineral leasing, but a part of their service relates to general investigations of mineral resources. Approximately two-fifths of the time of B. D. Stewart, who is in direct charge of the local offices, is allotted to general investigations of mineral resources, including visits to different parts of the Territory as conditions warrant. Mr. Stewart's long familiarity with mining matters throughout the Territory and his availability for consultation at Juneau have made his advice much sought by many of the Federal and Territorial agencies in Alaska, as well as by individual operators and prospectors. The Alaska offices also act as distributing points for publications of the Geological Survey and assist in furnishing the main office at Washington with information on many phases of the mineral industry of the Territory.

The customary broad survey of recent developments in the mining industry as a whole, with special visits to some of the more active mining camps or those that have not been recently visited by members of the Geological Survey, was made by Philip S. Smith, chief Alaskan geologist. Earlier in the year Mr. Smith had attended the Fourth Pacific Science Congress in Java as one of the official delegates of the United States.

A field project in Alaska that does not fall within the jurisdiction of this branch was carried on by the volcanologic section of the geologic branch. Austin E. Jones, the representative of this section, reports that during July and August he installed specially designed and constructed seismographs at Dutch Harbor and Kodiak. The records obtained will be not only used to disclose the earth movements at those places but studied in connection with general volcanologic investigations relating to the whole northern Pacific Ocean Basin that are also being carried on simultaneously at stations in Hawaii and California.

In all the office work on the technical reports resulting from the field work the members of the Alaskan branch have received much assistance and valuable advice from their associates in other branches of the Geological Survey. T. W. Stanton, G. H. Girty, J. B. Reeside, jr., Edwin Kirk, David White, and E. W. Berry, paleontologists, have examined and reported on the fossils collected. The map editors have been especially helpful in critically scrutinizing the Alaska maps that were in course of preparation to see that they conform so far as practicable to the best Geological Survey standards.

The areas reported in the following table are based on the field season and not on the fiscal year. For this reason no account is taken of the work that was started during the field season of 1930 but remained uncompleted at the end of the fiscal year.

Areas surveyed by Geological Survey in Alaska, 1898-1929, in square miles

Field season	Geologic surveys			Topographic surveys		
	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)
1898-1928.....	75, 150	174, 305 3, 675	4, 277	55, 630	206, 530 1, 375	4, 066
Percentage surveyed of total area of Alaska.....	75, 150	176, 330	4, 277	55, 630	209, 905	4, 066
	43.6			46.0		

* Includes 1,650 square miles revised extensively in 1929, included also under 1929, and therefore counted only once in the total.

In this table only the net areas surveyed are listed in the appropriate column, though of course most of the areas that have been surveyed geologically have also been surveyed topographically. It is by no means unusual that areas surveyed hastily at first are later resurveyed with more precision on the same or a larger scale, and if the areas thus revised were not excluded from the totals the same areas would be counted twice.

The scale most commonly adopted for Alaska surveys, either geologic or topographic, is the reconnaissance scale (1:250,000), about 4 miles to the inch, with a contour interval of 200 feet. This scale is adequate for most general purposes, and the maps can be made expeditiously and cheaply. Obviously, however, so small a scale can not effectively show detailed features of topography or geology, and yet many of these are of prime importance in their relations to the mineral resources of the region. There is a constant demand for more detailed work, and this demand will become more and more insistent as the Territory develops. The present rate at which the work is being carried on is entirely inadequate to meet even the most general needs, and the requisite detailed mapping of the most promising tracts must be postponed far into the future or must supplant the equally pressing reconnaissance work unless more funds are available with which to speed up the work.

PROJECTS FOR THE SEASON OF 1930

Nine projects have been approved for the season of 1930. These projects had been under way for only a short time at the end of the fiscal year, and no specific details are available regarding the work accomplished. Seven of these projects which involve field work are reconnaissance topographic mapping in the Ketchikan district, geologic and mining studies in the Taku Valley near Juneau, geologic investigations in the vicinity of the Alaska Railroad, geologic reconnaissance mapping of part of the Chulitna Valley and adjacent parts of Broad Pass, exploratory and reconnaissance topographic surveys in the Nushagak and adjacent areas of southwestern Alaska, geologic reconnaissance of the region lying north of the Yukon and adjacent to the international boundary, and a study of the general mining developments and conditions, with visits to such of the camps as time and other conditions permit. The two projects that do not directly involve field work are the annual canvass of the mineral production from Alaska in 1930 and the preparation of the aerial photographs resulting from the Navy Department expedition in southeastern Alaska in 1929.

The topographic work in the Ketchikan district is needed by the Geological Survey in its studies of mineral resources and by the Forest Service and others who are concerned with the development of the power and pulpwood resources of the region. The party is in charge of R. H. Sargent, topographic engineer, and the work should be much facilitated by the fact that a drainage map of the entire area had been compiled from the aerial photographs taken by the Navy Department in 1926.

Late in 1928 and early in the spring of 1929 finds of sulphide ore in the Taku region, mostly within British Columbia, were reported and created considerable interest in the region, not only locally but sufficient to induce many outsiders to visit the field. In 1929 certain members of the Geological Survey viewed part of this region from the Navy airplanes, and it became apparent that there was a strip about 10 to 15 miles wide adjacent to the boundary but within the United States that might be worth prospecting. In order to obtain more adequate information regarding this area B. D. Stewart was assigned to carry on investigations there during the season of 1930.

The work in the vicinity of the Alaska Railroad was undertaken primarily in response to repeated requests from Col. O. F. Ohlson, as head of the railroad, that the Geological Survey assist by giving information as to ore deposits that might contribute to the tonnage carried by the railroad and by considering

me of the technical problems relating to mining that arise in connection with the operation of the railroad. As a result F. H. Moffit, who for more than 15 years has been engaged in the Alaska work, was assigned to the project. He will render the precise service that can be rendered will have to be determined in the course of the work, but much of the time of the party will doubtless be devoted to the field examination of areas known to be more or less mineralized. The problem of assisting the mining industry of the Territory to take full advantage of the transportation facilities afforded by the railroad falls closely within the scope of the investigations that the Geological Survey has been carrying on for nearly a third of a century.

Related to the general problem of determining the mineral resources of the country near the Alaska Railroad are the investigations in the region adjacent to the head of Chulitna River, near Broad Pass, on the south flank of the Alaska Range. This work involves the geologic reconnaissance of an area of nearly 1,000 square miles that had been surveyed topographically in earlier years but had not been examined geologically. S. R. Capps will be in charge of this survey. Close cooperation will be maintained between the Moffit and Capps parties, so that if time is available they may supplement the work of each other and examine additional mining camps adjacent to the railroad, knowledge of whose general conditions will have a bearing on the general problems of the region.

In southwestern Alaska, north of Bristol Bay, remote from ordinary lines of travel, is one of the largest unsurveyed tracts in Alaska, about which almost nothing is known. Near-by regions that have been examined by Geological Survey parties are mineral bearing, and there is strong reason for believing that the mineralization may extend into this region also. An expedition to determine these conditions, as well as the major features of the topography and other geographic facts, was assigned to Gerald FitzGerald, who reached the region by airplane from Anchorage. The principal purpose of the survey will be to serve as a guide in formulating more comprehensive plans for the geologic and topographic reconnaissance of the whole tract between Bristol Bay and the Kuskokwim, if the results obtained indicate the desirability of such a project.

The large tract of country lying north of the Yukon River, adjacent to the international boundary and south of the Porcupine River, is another of the great areas of Alaska about which almost nothing is known and in which practically no surveys have been made. A preliminary reconnaissance geologic survey in the southern part of this area is in charge of J. B. Mertie, jr. Some lines of evidence suggest that conditions favorable for local mineralization may be found in the region; but even if the search should not disclose mineral deposits of value, the area is likely to be of great geologic significance because observations made near its borders indicate that it is likely to contain one of the most complete Paleozoic sections to be found anywhere in Alaska and one that has undergone relatively little metamorphism. The general information that such a section is able to shed on the whole Paleozoic geology of Alaska can hardly be overestimated.

The general survey of Alaska mining conditions by the chief Alaskan geologist and the collection of statistics regarding the mineral output of Alaska will follow the same lines as heretofore.

If time and funds are available, a start will be made on the compilation, from the aerial photographs, of drainage maps of additional areas in southeastern Alaska. The Geological Survey has already received letters stating that the small drainage map of parts of the Ketchikan-Hyder region alone has saved thousands of dollars to persons developing the timber and power resources of that region. There is an equally urgent demand that a start on a similar mapping program be made in the vicinity of Juneau and on Admiralty Island, for which pictures are also available.

EXPENDITURES

The funds appropriated for the work of the Geological Survey on Alaska's mineral resources are generally made available immediately on the passage of the act, so that during a large part of any field season two appropriations are running concurrently. The following

statement shows the principal objects for which the funds appropriated during the fiscal year 1930 were expended:

Expenditures from funds appropriated for investigation of mineral resources of Alaska for the fiscal year 1930

Projects for the season of 1929.....	\$13, 016
Projects for the season of 1930.....	12, 700
Administrative salaries, July 1, 1929, to June 30, 1930.....	3, 410
All other technical and professional salaries, July 1, 1929, to June 30, 1930.....	29, 168
All other clerical and drafting salaries, July 1, 1929, to June 30, 1930.....	7, 894
Office maintenance and expenses.....	1, 312
	<hr/>
	67, 500

Of the \$25,716 allotted to field projects for the two seasons about 65 per cent was allotted to geologic or related general work and 35 per cent to topographic work.

The item for administrative salaries includes only those salaries that are directly related to general administration and does not include charges for administration such as each party chief is called on to perform with regard to the party in his charge. The low cost of administration is due principally to the fact that the administrative officers are engaged also in technical projects, which therefore bear their proportional charge of their salaries.

LEASING WORK

Part of the activities of the Alaskan branch are related to the proper conduct of mining work on the public mineral lands that have been or may be leased to private individuals or corporations under certain laws. Funds for this work throughout the United States are provided in a general item contained in the Interior Department appropriation act. The amount that was allotted to Alaska for the fiscal year 1930 was \$10,000.

In order that the policies and practices that have been developed by the leasing unit of the conservation branch of the Geological Survey for handling the much larger volume of similar work in the States should be maintained in Alaska and at the same time the specialized knowledge of Alaska affairs possessed by the Alaskan branch should be utilized, the general conduct of the leasing work in Alaska is in a measure shared between the two branches, the office work in Washington being done principally by the conservation branch and the field work by the Alaskan branch. B. D. Stewart, supervising engineer, who has headquarters at Juneau, is in immediate charge of the field work, assisted by J. J. Corey, coal mining engineer, at Anchorage. The use of the same personnel and facilities for both the leasing work and the work on mineral resources avoids duplication of activities, lowers costs, and focuses the technical facilities on the main problem, which is the development of the Territory's mineral resources. At present about three-fifths of Mr. Stewart's time, all of Mr. Corey's time, and two-thirds of the time of a clerk in the Anchorage office are considered to be devoted to the leasing work. In the fiscal year 1930 the allotment for field expenses was approximately \$1,500, an amount that is inordinately low and that

proved adequate only because the Alaska Railroad has extended to the limit its services in facilitating the movement of the engineers.

The primary purpose of the leasing work is to supervise the operations under the coal and oil leases or permits that have been granted by the Government and to advise and consult with the proper authorities, both Federal officers and private applicants, regarding lands that may be under consideration for lease or permit. Practically all the coal mining and much of the oil prospecting in Alaska is done on public lands by private individuals or companies under leases or permits issued by the Secretary of the Interior. The interest of the Government in these lands requires not only that these grants shall be a source of revenue to the Nation but that proper methods of extracting the minerals shall be employed, thus preventing waste or damage to the property, and that the lives, health, and welfare of those engaged in the work shall be properly safeguarded. Practically all the producing coal mines that have been opened in the Territory are in the region adjacent to the Alaska Railroad. The Government has therefore an especial interest in their successful operation. For this reason the Federal engineers have given intensive study to the problems confronting these mines and have been especially active in supervising their operations, not only to see that the terms of the leases are observed but also to be of as much assistance as possible to the small operators who are opening them, by giving them competent technical advice and aiding them in making their ventures successful. This service is appreciated by the operators, and the relations between them and the engineers are extremely cordial and friendly, with no hint of the antagonism that sometimes exists between inspector and inspected.

TOPOGRAPHIC BRANCH

J. G. STAACK, Chief Topographic Engineer

ORGANIZATION AND PERSONNEL

Changes in the administrative personnel of the topographic branch were necessitated by the resignation of Col. C. H. Birdseye, who had been chief topographic engineer since October 1, 1919, and under whose leadership the technical work had made notable advances. At the end of the year the organization of the topographic branch was as follows:

- Atlantic division, Albert Pike, division engineer, in charge.
 - Central division, H. H. Hodgeson, division engineer, in charge.
 - Pacific division, T. G. Gerdine, division engineer, in charge.
 - Section of inspection and editing, W. M. Beaman, topographic engineer, in charge.
 - Section of computing, G. W. Hawkins, geodetic engineer, acting in charge.
 - Section of photographic mapping, J. H. Wheat, topographic engineer, in charge.
 - Section of cartography, A. F. Hassan, cartographic engineer, in charge.
 - Map information office, J. H. Wheat, topographic engineer, in charge.
- Including the above-named engineers, the technical force comprises 169 topographic, geodetic, or cartographic engineers of various grades and 71 engineering field aides and draftsmen of various grades—a total of 240—a corps of trained topographic engineers larger than that of any other similar organization in the world. The clerical force comprises 16 clerks.

EXPENDITURES

An analysis of the expenditures for topographic mapping in the table which follows will show that the Geological Survey supplements to a large extent its own appropriations with State and other Federal funds for similar purposes, under a policy of cooperation which standardizes the topographic work and reduces its cost. Thus the total expenditures for topographic mapping were \$1,286,589.85.

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1930

State or project	Appropriation for topographic surveys	Transfers and repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Topographic surveys, 1930	\$635,000.00	\$127,368.76	\$672,368.76	\$441,851.91	\$1,204,220.67
Great Smoky National Park, 1929-30	57,945.84		57,945.84		57,945.84
Shenandoah National Park, 1929-30	33,924.78		33,924.78		33,924.78
Total funds available	726,870.62	127,368.76	854,239.38	441,851.91	1,296,091.29
Expenditures:					
Alabama	8,072.75		8,072.75	10,000.00	18,072.75
Arizona	7,775.25		7,775.25		7,775.25
Arkansas	868.03	28.33	891.36		891.36
California	53,702.44	1,216.09	54,918.53	54,706.46	109,625.99
Colorado	13,732.50		13,732.50	5,000.00	18,732.50
District of Columbia		1,916.81	1,916.81		1,916.81
Georgia		21,082.49	21,082.49		21,082.49
Hawaii	12,539.92	997.48	13,537.40	21,309.34	34,846.74
Idaho	12,639.70	107.24	12,836.94	1,000.00	13,836.94
Illinois	75,002.74		75,002.74	56,884.80	131,887.54
Iowa	2,021.89		2,021.89	1,453.06	3,474.95
Kentucky	62,234.72		62,234.72	48,779.13	111,013.85
Maine	47,033.97	8,163.36	55,197.33	44,453.39	99,650.72
Michigan	34,636.86		34,636.86	23,945.48	58,582.34
Minnesota	2,077.34	25,810.17	27,887.51	3,086.98	30,974.49
Missouri	4,502.41		4,502.41	3,600.00	8,102.41
Montana	11,085.07		11,085.07		11,085.07
Nevada	5,287.89		5,287.89	1,910.88	7,198.77
New Hampshire	15,273.73		15,273.73	15,772.63	31,046.36
New Mexico	702.72		702.72		702.72
New York	3,513.92		3,513.92	8,653.98	12,167.90
North Carolina	28,672.48		28,672.48		28,672.48
North Dakota	2,783.75		2,783.75	1,914.40	4,698.15
Oklahoma	17,734.88		17,734.88	13,387.36	31,122.24
Oregon	14,457.54	9,072.67	23,530.21	4,287.58	27,817.79
Pennsylvania	23,558.89		23,558.89	24,997.50	48,556.39
South Carolina		21,894.44	21,894.44		21,894.44
Tennessee	41,195.04	1,266.25	42,461.29	13,999.23	56,460.52
Texas	48,077.14		48,077.14	37,148.37	85,225.51
Utah	11,928.89		11,928.89		11,928.89
Vermont	9,119.23		9,119.23	4,957.26	14,076.49
Virginia	65,185.00		65,185.00	22,425.99	87,610.99
Washington	11,486.24	30,134.85	41,621.09	1,284.91	42,906.00
West Virginia	3,264.93		3,264.93	2,500.00	5,764.93
Wisconsin	21,620.75	310.34	21,931.09	14,394.18	36,325.27
Wyoming	6,339.33		6,339.33		6,339.33
Miscellaneous repay.		5,278.24	5,278.24		5,278.24
Computing	*3,088.11		3,088.11		3,088.11
Contingent	550.54		550.54		550.54
Field distribution offices	600.00		600.00		600.00
Instruments (field)	*3,138.55		3,138.55		3,138.55
Stationery (field)	183.04		183.04		183.04
Inspection and editing	*6,691.85		6,691.85		6,691.85
Map information	3,551.50		3,551.50		3,551.50
One-millionth maps	8,196.74		8,196.74		8,196.74
Office of the chief topographic engineer	*8,170.87		8,170.87		8,170.87
Photographic mapping	*4,902.92		4,902.92		4,902.92
Books for library	172.12		172.12		172.12
Total expenditures	*717,309.18	127,368.76	844,737.94	441,851.91	1,286,589.85
Unexpended balance	*9,501.44		9,501.44		9,501.44
Grand total	726,870.62	127,368.76	854,239.38	441,851.91	1,296,091.29

* Represents noncooperative portion of total cost; balance included in charges for State cooperation.

* Includes office salaries.

* \$302,761.66 expended on State cooperation.

* Includes \$7,020.10 Great Smoky National Park funds available during the fiscal year 1931.

GENERAL OFFICE WORK

Incidental to the field work there is necessary office work, which consists in the inking and inspection and editing of the topographic field sheets prior to their submission for reproduction, in the computation and adjustment of the results of control field work, and in the preparation of partial culture and drainage bases from aerial photographs. During the year base maps of South Carolina, Texas, and Colorado were revised, republication of State maps being a valuable service to the users of maps who desire the State units. Stereoscopic mapping of the upper Columbia River, Washington, from aerial photographs was begun. Cooperation with the Air Corps, United States Army, was continued whereby aerial photographs were furnished for use in topographic mapping. In addition to this cooperative aerial photography, contracts were awarded to commercial firms for aerial photographic work, and the increased use of this valued adjunct to topographic mapping necessitates much skilled office work. (See also p. 81, Inspection and editing of topographic maps.)

SUMMARY OF RESULTS

The condition of topographic surveys to June 30, 1930, is shown on Plate 1. The status of topographic surveys is set forth in the following table, which shows a notable increase in the area covered by new surveys and resurveys, as compared with the preceding year. California, Illinois, Kentucky, Maine, and Texas are the States in which the largest amount of work was done, owing to their large cooperative appropriations. The Territory of Hawaii has taken its place with the few States completely mapped; and it may be further noted that the country as a whole is now 44.2 per cent mapped, the year's increment amounting to six-tenths of 1 per cent. The resurveys in large part covered areas previously surveyed on a smaller scale.

New topographic surveys of the United States, July 1, 1892, to June 30, 1930, and total area surveyed in each State

State	Publication contour interval (feet)	Mapped in fiscal year (square miles) for publication on scale of 1 to—					Total area mapped in fiscal year (square miles)			Total area mapped to June 30, 1930 (square miles)	Percent- age of total area of State mapped to June 30, 1930	River sur- vey, scale 1 : 31,680 (linear miles)	Spirit levels (miles)	Transit traverse (miles)	Triangulation stations occupied
		12,000	20,000	24,000	31,680	62,500	125,000/250,000	Revi- sion	Resur- vey	New survey					
Alabama.....	20					126			126	21,491	41.3				
Arizona.....	5, 20, 100						618		120	58,896	51.7			110	
Arkansas.....										120	40.7				
California.....	5, 20, 25, 100		467	376			10	2,944	773	128,875	81.4	1,123			113
Colorado.....	15					282			4	55,825	53.7	67			9
Connecticut.....	25, 50									4,965	100.0				
Delaware.....										2,370	100.0				
District of Columbia.....	1									2,370	100.0				
Florida.....									(*)	8.0	8.0		1	2	
Georgia.....	5, 20									4,716	41.9				
Idaho.....	5, 20, 100			133					133	24,835	37.0	601			
Illinois.....	5, 10, 20			161		1,839		287	461	31,033	58.6	124			8
Indiana.....										33,183	10.1	1,060		973	
Iowa.....										3,668	10.1				
Kansas.....	20									13,167	23.5	75		188	
Kentucky.....										64,159	78.1				
Louisiana.....	20					1,384				26,620	65.6	692		966	
Maine.....						1,408				8,823	18.2				
Maryland.....										15,814	47.9	711		468	33
Massachusetts.....										12,327	100.0				
Michigan.....	5, 10					379				8,266	51.0	510		578	
Minnesota.....	2					561				8,013	23.9	268		237	
Mississippi.....										3,985	8.5				
Missouri.....	20					196			196	43,083	62.1				
Montana.....	5, 20, 100		30				381			42,302	28.8				
Nebraska.....										27,117	33.0				
Nevada.....	100									46,466	42.0				16
New Hampshire.....	20					464		1,824		8,485	90.8	35		22	11
New Jersey.....										8,224	100.0				
New Mexico.....	5, 25									41,915	34.2	33			
New York.....	20			23		196			196	49,204	100.0				
North Carolina.....	20					134			134	19,040	36.3	180		16	
North Dakota.....	10			72					72	13,148	18.0				
Ohio.....										41,040	100.0				
Oklahoma.....	20					719				41,927	59.8	38		334	
Oregon.....	2, 5, 10, 25, 50, 100			48			789		30	32,569	33.7	18		60	4
Pennsylvania.....						1,100			230	36,633	81.2	431		392	
Rhode Island.....	20									1,248	100.0				

South Carolina.....	5, 20	145							18,737	44.3	245	135
South Dakota.....	5, 20		104	416					14,243	24.8		
Tennessee.....	5, 20								23,556	56.1	405	457
Texas.....	1, 2, 5, 10, 25	6	685	144					88,176	33.2	667	256
Utah.....	50		69						19,172	22.6		19
Vermont.....	20			280					7,775	81.3		
Virginia.....	20		253	394					37,749	88.6	792	951
Washington.....	20		15	92					35,656	51.6	18	
West Virginia.....	2, 5, 10, 20, 25, 50			1, 121					24,170	100.0	563	424
Wisconsin.....	20			569					18,724	33.4	109	190
Wyoming.....	5, 20, 100						296		30,670	31.3	32	
Total continental- United States (ex- clusive of Alaska).....												
Hawaii.....	2, 10, 20	23 (^a)	1, 143	2, 274	11, 145	4, 768	2, 571	3, 839 (^c)	16, 784	44.2	9, 168	6, 740
			• 96		330				6, 435	100.0	2	4
												216
												8

^a Surveyed on scale of 1:48,000.

^b 18 acres mapped on scale of 1:2,400.

^c Mapped on scale of 1:4,800.

^d Includes advance sheet edition for 57 square miles for final publication on a scale of 1:62,500.

^e Mapped on scale of 1:2,400.

^f 112 acres mapped on scale of 1:4,800.

^g Advance sheet editions in 10-foot contours; final publication in 50-foot contours and on a scale of 1:62,500.

FIELD SURVEYS

Alabama.—The State geologist of Alabama cooperating, the survey of the Cottondale quadrangle was continued and that of the Blocton quadrangle was begun.

Arizona.—The survey of the Turret Peak quadrangle and of the north half of the Cave Creek quadrangle was completed for the Forest Service.

California.—In cooperation with the State engineer of California the survey of the Mouth of Kern, Rockpile School, Adobe Station, Millux, Conner, Bear Mountain, Waits, Edison, Bena, and West Elk Hills quadrangles and the revision of the Rosedale quadrangle were completed and the survey of the Pentland Junction quadrangle was begun. In cooperation with the county surveyor of Los Angeles County, the survey of the Sylmar, Dume Point, Roosevelt School, Humphreys, Lancaster, Oban, Lang, Saugus, No. 7, No. 5, and Flat quadrangles was completed, that of the Del Valle quadrangle was continued, and that of the Llano, Lovejoy Springs, Casa Desierto, Wilsona, and Ravenna quadrangles was begun. In preparation for geologic mapping, the survey of the Crucero quadrangle was completed. At the request of the Forest Service, the survey of the Hoaglin quadrangle was begun.

Colorado.—The survey of the Telluride mining district and of Abrams Mountain and vicinity was continued, that of Galena Mountain and vicinity was completed, that of Snowmass Mountain No. 4 quadrangle was begun, and that of part of the Montezuma quadrangle was revised. This work was done in cooperation with the Colorado Metal Mining Fund. In cooperation with the Colorado Geological Survey Board the survey of the Sugar Loaf-St. Kevin area was completed and that of the Kokomo area, Rico district, and Nederland area was begun. For the Forest Service, the survey of the Dillon quadrangle was completed.

District of Columbia.—The survey of the naval hospital grounds was completed for the Navy Department, maintenance, Bureau of Yards and Docks.

Georgia-South Carolina.—The survey of the upper Savannah River Basin covering the Broad and Seneca Rivers with tributaries, the Tugaloo River, and parts of the drainage areas of the Little River, Ga., and the Little River and Stevens Creek, S. C., was completed in cooperation with the United States Army district engineer, Savannah.

Hawaii.—In cooperation with the commissioner of public lands of the Territory of Hawaii and the War Department the survey of the Wahiawa, Lae Kaena, Kaawa, Kaipapau, Kahana, and Haleiwa quadrangles, a revision of part of the Kaneohe quadrangle by aerial photography, and a revision of parts of the Waipio, Hamakua, Kilauea, Hilo, Mauna Loa, Kohala, and Waikiki quadrangles were completed. A survey of a part of the Wainanae quadrangle on the island of Oahu, was completed for the Navy Department.

Idaho.—The survey of the Bayhorse quadrangle was completed in preparation for geologic mapping.

Illinois.—The survey of the Annawan, Hettick, Arenzville, Decatur, Manito, Cahokia, and Geneva quadrangles, Money Creek Reservoir, highway projects Nos. 129 (Effingham quadrangle), 130 (Rose Hill quadrangle), 87 (Woosung quadrangle), 15 (Mount Vernon, Richview, Ina, and Duquoin quadrangles), 132 (Prairie Home, Lovington, Mattoon, and Arcola quadrangles), 92 (Walnut and Amboy quadrangles), and 77 (Forreston quadrangle), and Decatur and vicinity was completed, that of the Jerseyville quadrangle was continued, and that of the Maron, Niantic, Sycamore, Monks Mound, French Village, Granite City, Dunlap, Lacon, and Metamora quadrangles and highway projects Nos. 119 (Delavan, Minier, McLean, Le Roy, Arrowsmith, and Gibson City quadrangles), 91 (Maquon and Galva quadrangles), and 93 (Toulin and Camp Grove quadrangles) was begun. All this work was done in cooperation with the Department of Registration and Education of Illinois, Geological Survey.

Kentucky.—The State geologist of Kentucky cooperating, the survey of the Springdale, Morning View, Somerset, Fordsville, Falmouth, Salt Lick, Cynthiana, and Sunnybrook quadrangles was completed, that of the Sadleville quadrangle was continued, and that of the Ekron, Rising Sun, Austerlitz, Vine Grove, Garrison, Vanceburg, and Kirk quadrangles was begun.

Maine.—In cooperation with the Public Utilities Commission of Maine the survey of the Brooks, Portage, Beddington, Phillips, Caribou, and Great Pond quadrangles was completed and that of the Mapleton, Aroostook Mountain, Saponac, Allagash, Strong, Flanders Pond, Ashland, and Pittsfield quadrangles

was begun. In cooperation with the War Department the survey of the Robbinston and Calais quadrangles was completed and that of the Fort Fairfield and St. Francis quadrangles was begun.

Maine-New Hampshire.—The Highway Commission of Maine and the Highway Department of New Hampshire cooperated in completing a survey of the boundary between these two States north of the outlet of Great East Pond.

Michigan.—In cooperation with the Department of Conservation of Michigan, Geological Survey, the survey of the Holland quadrangle was completed, that of the Muskegon, Twin Lake, and Shepherd quadrangles was continued, and that of the Montague quadrangle was begun.

Minnesota.—In cooperation with the Department of Drainage and Waters of Minnesota, the survey of the Juneberry No. 3 and Juneberry No. 4 quadrangles was completed. The survey of the Roseau River Valley for the State Department was completed.

Missouri.—The survey of the Mexico quadrangle was completed in cooperation with the State geologist of Missouri.

Montana.—Preparatory to contemplated geologic mapping, the survey of the Libby quadrangle was continued. To meet the needs of the Biological Survey, Department of Agriculture, the survey of the National Bison Range was completed.

Nevada.—The survey of the Lovelock quadrangle was begun in cooperation with the Bureau of Mines of Nevada.

New Hampshire.—In cooperation with the Highway Department of New Hampshire, the survey of the Moosilauke, Franconia, Thetford, and Littleton quadrangles was completed, and that of the Percy, Dummer, Umbagog Lake, and Mohawk quadrangles was begun.

New Mexico-Texas.—The New Mexico-Texas Boundary Line Commission cooperating, the survey of the area adjacent to the New Mexico-Texas boundary line in the Rio Grande Valley was completed.

New York.—The survey of the Kinderhook and Schunemunk quadrangles was continued in cooperation with the Department of Public Works of New York.

North Carolina.—The survey of the boundary of the proposed Great Smoky Mountains National Park in North Carolina was continued.

North Dakota.—In cooperation with the State engineer of North Dakota the survey of the Souris River was completed.

Oklahoma.—The State Highway Commission of Oklahoma cooperating, the survey of the Kaw, Belford, and Pawnee quadrangles was completed.

Oregon.—The survey of the Pendleton quadrangle was continued and that of The Dalles and Dufur quadrangles was begun in cooperation with the State engineer of Oregon. For the Forest Service the survey of the Three Sisters quadrangle was completed.

Oregon-Washington.—The survey of the lower Columbia River between Vancouver, Wash., and Mayger, Oreg., was begun and a plan and profile survey of the Columbia River from Blalock to Hood River, Oreg., was completed. This work was done in cooperation with the United States Army district engineer, Portland, Oreg.

Pennsylvania.—In cooperation with the Department of Internal Affairs of Pennsylvania, Topographic and Geologic Survey, the survey of the Union City, Karthaus, Clearfield, Penfield, Easton, and Coalmont quadrangles was completed, and that of the Starrucca, Ralston, and Loyssville quadrangles was begun. The survey of the Tyrone quadrangle was completed in preparation for geologic mapping.

Tennessee.—With the cooperation of the State geologist of Tennessee the survey of the Hermitage quadrangle was completed and that of the Pegram quadrangle was begun. The survey of the boundary of the proposed Great Smoky Mountains National Park in Tennessee was continued. The survey of an experiment farm near Lewisburg was completed for the Department of Agriculture.

Texas.—In cooperation with the commissioners of Cameron County the survey of the Laguna Atascosa, Los Fresnos, Laguna Vista, La Coma, Paso Real, Combes, La Paloma, Burreda, La Feria, Santa Maria, Mouth of Rio Grande No. 2, Josephine Island No. 1, Josephine Island No. 2, Josephine Island No. 3, Josephine Island No. 4, Brownsville No. 1, Fort Brown No. 1, Fort Brown No. 2, Fort Brown No. 3, Fort Brown No. 4, and a part of Point Isabel No. 3 quadrangles was completed and the work on the Point Isabel No. 2, M M No. 2, and M M No. 3 quadrangles and the rest of the Point Isabel No. 3 quadrangle was completed by means of aerial photography. In cooperation with the Board

of Water Engineers the survey of the Archer 3-a and Archer 4-b quadrangles and four dam sites on the Colorado River between Austin and Marble Falls was completed and that of the Austin 2-b, Blanco 1-a, Burnet 3-d, and Burnet 4-c quadrangles was begun. In cooperation with the Reclamation Department of Texas the survey of the Harlem project was begun.

Utah.—The survey of the Zion National Park, for the National Park Service, was continued.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Ludlow quadrangle was completed, that of the Townshend quadrangle continued, and that of the Littleton quadrangle begun.

Virginia.—The survey of the Bonsacks, Stony Man, Riders Gap, and Salem quadrangles was completed and that of the Old Town, Independence, Warm Spring Run, Healing Springs, Stanardsville, and Montross quadrangles was begun, all in cooperation with the Conservation and Development Commission of Virginia, Geological Survey. The survey of the boundary of the proposed Shenandoah National Park was continued.

Washington.—The survey of the Colville quadrangle was completed in cooperation with the Department of Conservation and Development of Washington. To meet the needs of the Forest Service the survey of the Mount Constance quadrangle was begun. The aerial photographic survey of the upper Columbia River from the international boundary to Rock Island Rapids near Wenatchee and the survey of the Grand Coulee were completed in cooperation with the United States Army district engineer, Seattle, Wash.

West Virginia.—In cooperation with the State geologist of West Virginia the cultural revision was completed for the Eccles, Beckley, Flattop, Madison, and Peytona quadrangles and that of the Charleston and St. Albans quadrangles was begun.

Wisconsin.—In cooperation with the Geological and Natural History Survey of Wisconsin the survey of the Durand, Gilmanton, Prairie du Chien, and Ferryville quadrangles and the Graves Quarry area was completed, that of the Wabasha, Mondovi, and Boaz quadrangles was continued, and that of the Boscobel quadrangle was begun.

Wyoming.—The survey of the Jackson quadrangle for the Forest Service was continued.

WATER-RESOURCES BRANCH

N. C. GROVER, *Chief Hydraulic Engineer*

ORGANIZATION AND PERSONNEL

The water-resources branch, like other branches of the Geological Survey, is primarily an agency of research and investigation. It collects systematically for general public information and use facts in regard to the quantity, quality, and utilization of water. The widespread interest in the availability of water for many uses has led to a persistent and increasing demand for reliable data that would serve as a basis for safe and sane developments. During the year the varied work of the branch has been administered under the following units:

Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.

Division of ground water, O. E. Meinzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

The technical force at the end of the year comprised the chief hydraulic engineer, 1 principal hydraulic engineer, 29 senior hydraulic engineers, 15 hydraulic engineers, 140 associate, assistant, and junior engineers, 1 engineering field aide, 3 senior geologists, 1 geologist, 6 associate, assistant, and junior geologists, 1 senior chemist, 6 associate, assistant, and junior chemists, 4 laboratory assistants and apprentices—a total of 208. The clerical force comprised 39 clerks. The changes in personnel during the year show a net increase of 41.

FUNDS

The funds available for Geological Survey work on water resources were as follows:

Gaging streams	\$275,000.00
Transfers from Federal agencies	428,853.00
Repayments by Federal agencies	8,158.78
Funds furnished by States and municipalities	397,971.25
Funds furnished by permittees and licensees of the Federal Power Commission	38,603.39
	<hr/> 1,148,586.40

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Alabama	\$2,725.32
Arizona	16,075.00
Arkansas	6,568.13
California:	
State	\$44,899.63
Municipal	21,887.90
	<hr/> 66,787.62
Colorado	388.51
Connecticut	7,000.00
Hawaii:	
Territory	10,687.38
Municipal	4,613.86
	<hr/> 24,301.24
Idaho	16,467.18
Illinois	3,973.86
Kansas	5,103.32
Maine	7,204.34
Maryland:	
State	4,109.38
Municipal	1,868.21
	<hr/> 6,067.59
Massachusetts	7,623.71
Minnesota	322.46
Missouri	10,578.64
Montana	7,484.64
Nevada	1,788.00
New Hampshire	1,999.40
New Jersey	12,063.15
New Mexico	4,444.79
New York	17,860.82
North Carolina:	
State	11,627.73
Municipal	190.05
	<hr/> 11,817.78
Ohio:	
State	31,594.94
Municipal	892.36
	<hr/> 32,487.30

Oregon:		
State	\$9,391.07	
Municipal	806.13	
		\$10,197.20
Pennsylvania		1,506.64
South Carolina:		
Municipal		235.60
Tennessee		16,512.60
Texas:		
State	41,538.18	
Municipal	390.00	
		41,928.18
Utah		6,534.48
Vermont		7,110.21
Virginia		20,626.31
Washington:		
State	1,682.26	
Municipal	2,153.66	
		3,835.92
West Virginia		5,000.00
Wisconsin		7,232.19
Wyoming		6,069.06
		<hr/> 397,971.25

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects was continued in cooperation with the Bureau of Reclamation on the Black Canyon project and on the lower Colorado River. The study of the conditions at the Avalon Dam of the Carlsbad irrigation project in New Mexico were continued, and reservoir sites at Red Bluff, Tex., and Owyhee, Oreg., were investigated.

Indian Service.—Stream gaging was continued for the Indian Service in the Western Shoshone Reservation and on the Gila and San Carlos Rivers. Examinations were made of available sources of ground-water supplies for the Rosebud Indian Agency.

National Park Service.—Streams in the Yellowstone National Park were measured during the year at stations maintained in cooperation with the National Park Service.

Department of the Navy.—A study of a water supply for the proposed naval ammunition depot at Lualualei, Oahu, was made for the Bureau of Yards and Docks.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service.

Weather Bureau.—Stream gaging has been continued on the Colorado River in Arizona in cooperation with the Weather Bureau.

Office of Public Buildings and Public Parks of the National Capital.—A study of the flow of Rock Creek was undertaken in cooperation with the Office of Public Buildings and Parks. This study will be of special value in determining the effect of development in the District of Columbia and surrounding suburbs on the flow of the creek.

Department of State.—Stream gaging and investigations concerning water-utilization and flood-control problems have been continued on the Rio Grande on the Mexican boundary and on numerous streams on and near the Canadian boundary from the Lake of the Woods westward. Notable centers of activity on the Canadian boundary have been the Roseau River in Minnesota, the St.

Mary and Milk Rivers in Montana, and the Kootenai River in Idaho. Some of these operations on the Canadian boundary are being conducted jointly with Dominion officials because of the common interest of the two countries in them. The cost of this work is met by funds transferred to the Geological Survey by the Department of State.

Department of Justice.—An investigation of ground-water supplies for the proposed Camp Lee prison farm, Virginia, was made for the superintendent of prisons.

Corps of Engineers, United States Army.—Stream gaging has been continued in cooperation with the Corps of Engineers in connection with flood control and with studies and reports to be made under House Document No. 308 of the Sixty-ninth Congress, first session. This work has been carried on at Boston, Providence, New York, Philadelphia, Baltimore, Washington, Norfolk, Huntington, Wilmington, Charleston, Chattanooga, Nashville, Florence, Montgomery, Mobile, Galveston, Jacksonville, Vicksburg, Louisville, Cincinnati, St. Paul, Kansas City, Seattle, Portland, and San Francisco and includes about 600 gaging stations. The cost of this work is met by transfers from the funds of the Corps of Engineers.

Federal Power Commission.—The stream gaging required by the Federal Power Commission in permits and licenses issued for the development of water power under the Federal water power act has been performed or supervised by engineers of the Geological Survey in Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Iowa, Indiana, Kentucky, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, New Mexico, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Tennessee, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming. The operation of constructed projects or those under construction has been supervised in Arizona, Arkansas, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wisconsin, and Wyoming.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 29 reports by 6 separate chapters. (See pp. 5-6.) At the end of the year 18 other reports were in press.

CHARACTER AND METHOD OF WORK

The study of surface waters, which consists primarily of the measurement of the flow of streams, has been conducted in 47 States and Hawaii at selected gaging stations at which the volume of water carried by the streams is measured and records of stage and other data, from which the daily flow of the stream is computed, are collected. At the end of the year 2,426 gaging stations were being maintained; 241 stations were discontinued and 429 new stations established during the year. Records for about 161 additional stations were received, ready for publication, from Government bureaus and private persons, and several Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

The division of ground water investigates the waters that lie below the surface—their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to the chemical composition of the water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects. During the fiscal year about 48 investigations relating to ground water and reservoir sites were in progress, and work was conducted in 26 States and Hawaii. The demands of the public for precise information in regard to ground-water resources are becoming more and more exacting with increasing need for the water. In recent years considerable research into the principles of ground-water hydrology has been undertaken in the division in order to provide a more secure basis for ground-water investigations.

Cooperation was continued with the eight State associations of water-well drillers and with the newly organized American Association of Water Well Drillers. Mr. Meinzer delivered an address at the meeting of this association in Minneapolis February 6, on the past and future of the water-well drilling industry. A number of papers were delivered at the meetings of the State associations by A. G. Fiedler and R. M. Leggette, most of which have since been published in trade journals. Mr. Fiedler represents the Geological Survey on the advisory council of the American association and has been chosen executive secretary of that council.

A paper by Mr. Meinzer, entitled "Outline of Methods of Estimating Ground-water Supplies," was transmitted for publication by the American Society of Civil Engineers. Abstracts of papers relating to ground-water hydrology were prepared for the Annotated Bibliography of Economic Geology and for foreign abstract journals.

A new apparatus has been constructed by C. H. Au for exploring leaky wells by the electrolytic method for salinity of the water at all depths. Work was resumed in the hydrologic laboratory by V. C. Fishel, working under the direction of F. G. Wells.

The work on quality of water included the analysis of the mineral content of 1,180 samples of water from surface and underground sources. These included some analyses for nearly all the studies of ground water in the different States, as noted below. Studies of dissolved and suspended matter in the Colorado River and its tributaries were continued. S. K. Love spent 10 weeks in the summer of 1929 on an intensive study of suspended matter in the San Juan River at Goodridge, Utah.

The work of the division of power resources comprised the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants, a report on the developed water power of the United States, a report containing the monthly and annual figures of output by States for 1927 and

1928, and compilations of the stocks of coal held by electric public-utility power plants for inclusion in reports of commercial stocks of coal undertaken quarterly by the Bureau of Mines of the Department of Commerce. Cooperation was given to the Bureau of Mines of the Department of Commerce and the Institute of Economics of the Brookings Institution in the preparation of a report on the origin of the coal and the kinds of stokers used by coal-burning electric public-utility power plants.

The monthly and annual figures of output of electricity and fuel consumption are based on reports submitted by concerns producing electricity for public use. On January 1, 1930, 1,628 companies, operating 3,780 power plants with a total capacity of generators of 31,952,396 kilowatts, were on the list of companies requested to submit reports. Plants whose output is less than 10,000 kilowatt-hours a month are generally not included. Reports are received from plants representing over 95 per cent of the capacity of all plants listed. The output of plants not reporting is estimated.

Annual production of electricity by public-utility power plants in the United States, 1919-1929

Year	Total			Water power			Fuel power		
	Kilowatt-hours	Change from previous year	Per cent	Kilowatt-hours	Per cent of total	Change from previous year	Kilowatt-hours	Per cent of total	Change from previous year
1919.....	38,921,000,000			14,606,000,000	37.5		24,315,000,000	62.5	
1920.....	43,555,000,000	+11.9		16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+17.7
1921.....	40,975,000,000	-5.9		14,970,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922.....	47,654,000,000	+16.3		17,207,000,000	36.1	+14.9	30,447,000,000	63.9	+17.1
1923.....	55,665,000,000	+16.8		19,343,000,000	34.8	+12.4	36,322,000,000	65.2	+19.3
1924.....	59,014,000,000	+6.0		19,969,000,000	33.8	+3.2	39,044,000,000	66.2	+7.5
1925.....	65,870,000,000	+11.6		22,356,000,000	33.9	+11.9	43,514,000,000	66.1	+11.4
1926.....	73,791,000,000	+12.0		26,189,000,000	35.5	+17.1	47,602,000,000	64.5	+9.4
1927.....	80,205,000,000	+8.7		29,875,000,000	37.2	+14.1	50,330,000,000	62.8	+5.7
1928.....	87,850,000,000	+9.5		34,696,000,000	39.5	+16.1	53,154,000,000	60.5	+5.6
1929.....	97,352,000,000	+10.8		34,629,000,000	35.6	-0.2	62,723,000,000	64.4	+18.0

Annual consumption of fuel in the production of electricity by public-utility power plants in the United States, 1919-1929

Year	Coal		Fuel oil		Gas	
	Short tons	Change from previous year	Barrels	Change from previous year	M cubic feet	Change from previous year
1919.....	35,100,000		11,050,000		21,406,000	
1920.....	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921.....	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.0
1922.....	34,179,000	+8.2	13,197,000	+9.6	27,172,000	+14.5
1923.....	38,906,000	+14.0	14,684,000	+11.3	31,433,000	+15.7
1924.....	37,556,000	-3.6	16,630,000	+13.3	48,443,000	+54.1
1925.....	40,222,000	+7.1	10,246,000	-38.4	46,521,000	-4.0
1926.....	41,311,000	+2.7	9,399,000	-8.3	53,207,000	+14.4
1927.....	41,888,000	+1.4	6,782,000	-27.8	62,919,000	+18.3
1928.....	41,350,000	-1.3	7,158,000	+5.5	77,326,000	+22.9
1929.....	44,937,000	+8.7	10,124,000	+41.4	112,707,000	+45.8

The improvement each year in the utilization of fuel in the generation of electricity by public-utility companies continues, as indicated in the following table:

Average consumption of coal^a per kilowatt-hour by public-utility power plants in the United States, 1919-1929

Year	Pounds	Per cent of rate in 1919	Year	Pounds	Per cent of rate in 1919
1919.....	3.2	100	1925.....	2.1	66
1920.....	3.0	94	1926.....	1.95	61
1921.....	2.7	84	1927.....	1.84	58
1922.....	2.5	78	1928.....	1.76	55
1923.....	2.4	75	1929.....	1.69	53
1924.....	2.2	69			

^a Oil and gas included as equivalent coal.

Owing to the small amount of precipitation in some sections of the country in 1929 the production of electricity by the use of water power was for the first time since 1921 less than in the previous year.

A report on the amount of developed water power in the United States on January 1, 1930, was released February 17, 1930, and the final report on the annual production of electricity by public-utility power plants in 1929 was released May 24, 1930.

WORK OF THE YEAR BY STATES

The following table shows by States the number of gaging stations maintained for the collection of stream-flow records and the interest in those stations of the agencies cooperating with the Geological Survey:

Gaging stations and cooperating parties for the year ended June 30, 1930—Continued

State or Territory	Geolog- ical Survey alone	Bureau of Recla- mation	Forest Service	Indian Service	Army engi- neers	Weather Bureau	Other Federal bureaus	State coop- eration	Municipal coop- eration	Private persons	Count- ed more than once	Maintained at end of year	Estab- lished during year	Discon- tinued during year	Regular gagings during year	Miscel- laneous gagings during year
Utah.....	5	3					1	51	1	17	22	56	3	1	405	13
Vermont.....					3			18		8	12	23	2	1	148	
Virginia.....					23			65	2	13	73	80	15	3	294	14
Washington.....			1		55		9	107	22	41	106	129	25	9	1,062	100
West Virginia.....					29			28	1	9	10	57	17	1	356	13
Wisconsin.....					3			40		12	14	41	3		184	12
Wyoming.....		5		4	16	1	7	35		3	6	65	9	2	339	12
Hawaii.....								80	8	54	62	80	9	8	493	1,149
	10	17	28	11	600	46	128	1,716	191	730	1,061	2,426	429	241	21,114	2,191

Alabama.—Field work was continued, in cooperation with the Geological Survey of Alabama, in the area of Paleozoic rocks, and a report on the ground waters of this entire area, covering 25 counties, was prepared by W. D. Johnston, jr. Mr. Johnston also presented at the Charlottesville meeting of the Society of Economic Geologists a paper on the chemical character of ground water in northern Alabama and prepared papers for publication on the physical divisions of the Paleozoic area, on the caves of the area, with special reference to the work of ground water, and on the growth of stalactites.

Arkansas.—The investigation of the source and quantity of the ground-water supply for irrigation of rice in the area about Stuttgart was continued by D. G. Thompson, who prepared a preliminary report giving the results of the investigation to date. This investigation is conducted in cooperation with the Arkansas Geological Survey and the Arkansas Agricultural Experiment Station. A paper by M. D. Foster on the chemical character of the hot springs of Arkansas and Virginia was published in *Industrial and Engineering Chemistry*.

California.—Water levels were measured in selected wells in southern California under the direction of F. C. Ebert. The record now covers a period of 26 years. Work was continued, with financial support by the East Bay Municipal Utility District, on the investigation of the ground water in the alluvial fan of the Mokelumne River by H. T. Stearns, G. H. Taylor, C. A. McClelland, and L. K. Wenzel. The results of the investigation to July 1, 1929, were published as Water-Supply Paper 619. Measurement of wells in the Calaveras River area was continued in cooperation with the city of Stockton. Tests of samples of water-bearing material were made by Burt Burlingame at the laboratories of the State University at Davis. A preliminary survey of the quality of surface waters was initiated. Occasional samples for partial analysis will be collected at nearly all the gaging stations to furnish data on which to base a plan for a comprehensive study of the quality of surface waters.

Colorado.—A report on the upper Colorado River and its utilization, by Robert Follansbee, was published as Water-Supply Paper 617.

Hawaii.—A comprehensive investigation of the ground waters on the Island of Oahu was begun, and K. N. Vaksvik was assigned to compile the available data on the subject. A study of a water supply for the proposed naval ammunition depot at Lualualei, Oahu, was begun in cooperation with the Bureau of Yards and Docks of the Navy Department.

Idaho.—Ground-water investigations were continued in cooperation with the Idaho Department of Reclamation and the Idaho Bureau of Mines and Geology. A comprehensive report on the Snake River Plain and adjacent areas that contribute ground water to the Snake River was completed by H. T. Stearns, Lynn Crandall, and G. W. Steward. This report contains a map of the entire region showing 10-foot contours of the water table. A comprehensive report on the Mud Lake region, by H. T. Stearns and L. L. Bryan, was released to the public in manuscript form. Investigations with test drilling were made by Lynn Crandall and H. T. Stearns in the Big Lost River and Little Lost River valleys, and manuscript reports on both valleys, with recommendations for increasing the irrigation supply, were made public. An investigation of the ground-water levels in the Kootenai Valley below Bonners Ferry was begun, and T. R. Newell was assigned to take charge of the investigation.

Illinois.—A. G. Fiedler attended the annual meeting of the State well drillers' association and presented a paper on drilling methods.

Indiana.—A. G. Fiedler attended the annual meeting of the State well drillers' association and presented a paper on the relation of the well drillers to the waterworks field.

Iowa.—R. M. Leggette attended the annual meeting of the State well drillers' association and presented a paper on underground water in glacial drift.

Kansas.—A report on the ground-water conditions in the vicinity of the Haskell Institute, at Lawrence, by W. N. White, was transmitted to the Indian Service.

Kentucky.—A report on ground-water conditions in the vicinity of Madisonville, by W. D. Johnston, jr., was released to the public in manuscript form.

Michigan.—A. G. Fiedler attended the annual meeting of the State well drillers' association and presented a paper on sanitation of ground-water supplies.

Minnesota.—A branch office was maintained in Minneapolis, in charge of Mr. Fiedler, who is investigating well-drilling methods and cooperating with the State well drillers' associations.

Montana.—The study of ground-water levels in an area north of Flathead Lake in relation to fluctuations in the lake levels was continued by A. H. Tuttle, and a preliminary report thereon was transmitted to the Federal Power Commission by O. E. Meinzer, of the Geological Survey, and L. T. Jessup, of the Department of Agriculture. Work was continued by G. M. Hall in the preparation of reports on Big Horn and Fergus Counties.

Nebraska.—A. G. Fiedler attended the annual meeting of the State well drillers' association.

Nevada.—A brief examination of the ground-water conditions in Duck Lake Valley, through cooperation by the State engineer, was made by Mr. Meinzer, who prepared a report on the area that was released in manuscript form.

New Jersey.—A report on the ground-water supplies of the Passaic River Valley, near Chatham, was completed by D. G. Thompson and transmitted to the New Jersey Department of Conservation and Development for publication. Informal cooperation was continued with that department in the ground-water work that is being conducted by H. C. Barksdale.

New Mexico.—Investigations of ground-water resources in different parts of New Mexico were continued in cooperation with the State engineer. A comprehensive report on the Roswell artesian basin was practically completed by A. G. Fiedler and S. S. Nye. A preliminary report relating especially to water in the valley fill and artificial recharge of this artesian basin was prepared for the ninth biennial report of the State engineer. Investigation was continued in the Mimbres Valley by W. N. White, who prepared a preliminary report that has been made public in manuscript form and is to be published as a contribution to hydrology. An investigation of the ground-water resources of the northern part of Lea County was begun by Mr. Nye, who prepared a preliminary report on the area for the report of the State engineer. Further investigations were made by Kirk Bryan on conditions at the Avalon Reservoir of the Carlisbad irrigation project for the Bureau of Reclamation.

North Dakota.—Mr. Fiedler attended the annual meeting of the State well drillers' association and presented a paper on sanitation of water supplies.

Oregon.—Investigations of the ground-water resources of Oregon were continued by A. M. Piper in cooperation with the Oregon Agricultural Experiment Station. Progress was made on the investigation in the Willamette Valley, and a memorandum was transmitted to the director of the experiment station containing recommendations that led to the successful drilling of an experimental well for irrigation in the valley. An investigation of the ground water available for irrigation in the region of The Dalles was begun by Mr. Piper. A paper on ground water for irrigation was presented by Mr. Piper at the Corvallis meeting of the American Society of Agricultural Engineers. Further investigation was made by Kirk Bryan of the reservoir site of the Owyhee irrigation project for the Bureau of Reclamation. Investigations were made by Mr. Piper on about 30 dam sites in the western part of the State, and a report thereon was prepared for the conservation branch.

Pennsylvania.—The systematic survey of the ground-water resources of Pennsylvania was continued in cooperation with the State geologic and topographic survey, and progress was made by Mr. Leggette on his work in the northwestern part of the State.

South Dakota.—An investigation of the ground-water conditions in the Rosebud Indian Reservation was made by A. G. Fiedler for the Indian Service.

Tennessee.—Work was continued on a systematic survey of the ground-water resources of Tennessee in cooperation with the State geologist. A report on ground water in north-central Tennessee was prepared by A. M. Piper for publication, and a report on ground water in the vicinity of Memphis, by F. G. Wells, was made public in manuscript form. A survey was made by Mr. Wells of the ground-water conditions in 10 counties in the northwestern part of the State, and a report was prepared by him on the entire Coastal Plain area of western Tennessee.

Texas.—A systematic survey of the ground-water resources of Texas was undertaken in cooperation with the State board of water engineers under the direction of W. N. White. Field work was done in the Winter Garden region by T. W. Robinson, S. F. Turner, and A. N. Sayre, of the Geological Survey; and J. T. Lonsdale, of the Agricultural and Mechanical College of Texas. An investigation of the artesian conditions and conservation of the artesian-water supply in the vicinity of Glen Rose was made by A. G. Fiedler. The State department of health is also cooperating in the ground-water survey, and special investigations on the sanitary phases of ground water were made by Chester Cohen, of that department. Mr. White addressed the Texas Water-

works Short School at Abilene on methods that are being used in ground-water investigations made in the State. An examination of the Red Bluff and other dam sites on the Pecos River was made for the Bureau of Reclamation by Kirk Bryan.

Utah.—A report on the ground-water supply in the Escalante Valley was completed by W. N. White and is to be published as a water-supply paper. A brief examination of the ground-water supply available in the vicinity of Salt Lake City was made by O. E. Meinzer, and a report thereon was submitted to the city authorities. A report on Green River and its utilization, by Ralf R. Woolley, was published as Water-Supply Paper 618.

Virginia.—Investigation of the thermal springs of Virginia was continued in cooperation with the State Commission on Conservation and Development. Water-stage recorders were operated on the ebbing and flowing spring near Broadway and on the observation well in Arlington County. An examination of the ground-water conditions at Camp Lee was made by R. M. Leggette for the Department of Justice. A reconnaissance of the ebbing and flowing springs in the State was made by O. E. Meinzer. A preliminary report on the quality of surface waters of Virginia was practically completed. It contains analyses of 10-day composites of daily samples taken at 16 gaging stations for the year ended March 31, 1930. Analyses are being made of similar samples from 16 other gaging stations beginning April, 1930.

West Virginia.—A field trip was made by O. E. Meinzer to obtain information concerning the ebbing and flowing springs in West Virginia.

Wyoming.—A water-stage recorder was continued in operation on the ebbing and flowing spring near Afton.

CONSERVATION BRANCH

HERMAN STABLER, *Chief*

ORGANIZATION AND PERSONNEL

The volume and complexity of the work of the conservation branch, comprising the classification of public lands with respect to mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands, continued to increase during the fiscal year 1930 and was directed through four administrative divisions, as follows:

Mineral-classification division, J. D. Northrop, geologist, in charge.

Power division, B. E. Jones, hydraulic engineer, in charge.

Agricultural division, J. F. Deeds, hydraulic engineer, in charge.

Mineral-leasing division, H. I. Smith, mining engineer, in charge.

Personnel changes during the fiscal year included 24 separations and 26 additions. On June 30, 1930, the personnel of the branch, both office and field, numbered 151, consisting of 4 geologists, 8 hydraulic engineers, 11 mining engineers, 43 petroleum engineers, 8 agricultural classifiers, 1 chemist, 1 attorney, 20 accountants and draftsmen, and 55 clerical and miscellaneous employees.

FUNDS

The funds appropriated or transferred for the work of the conservation branch in the fiscal year were as follows:

Classification of lands.....	\$180,000
Supervision of leasing operations, public lands.....	250,000
Supervision of leasing operations, Indian lands.....	85,000
Supervision of naval-reserve operations.....	50,000
Plugging abandoned wells (available until June 30, 1931).....	50,000
Federal Power Commission.....	4,500

619,500

Exclusive of the special appropriation for plugging abandoned wells, this aggregate is \$15,000, or about 3 per cent, greater than the corresponding total in 1929.

CORRESPONDENCE

During the year 30,832 letter requests for information or technical reports were received in the Washington office of the branch, together with 30,150 pieces of miscellaneous correspondence for filing or for transmission to the appropriate field office. Within the same period 21,639 letters were answered and 17,600 pieces of miscellaneous correspondence were sent out.

SUMMARY OF LAND-CLASSIFICATION CASES

The activities of the conservation branch with respect to land classification include the preparation of reports in response to requests for data or action on specific cases, the preparation of orders of withdrawal and restoration of lands not involved in specific requests, and the promulgation of broad areal classifications. The following table summarizes activity with respect to requests for data or action on specific cases. The terms "gain" and "loss" signify, respectively, decrease and increase in the number of cases pending. By strenuous effort of an efficient personnel the number of cases acted on was greater by nearly 2,000 than during the preceding year. Nevertheless there were 1,042 more cases pending at the end of the year than at its beginning, an increase of about a third.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1930						Record since receipt of first case	
	Pending July 1, 1929	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1930	Gain or loss during fiscal year	Received	Acted on
General Land Office requests:								
General.....	300	1,493	1,793	1,386	407	-107		
Time extensions.....	6	0	6	6	0	+6	2,313	2,313
Oil development.....	17	18	35	34	1	+16	16,129	16,128
Concurrence.....	32	649	681	661	20	+12		
Committee cases—Oil.....	46	5,096	5,142	4,533	609	-563	5,680	5,071
Applications for classification as to mineral:								
Oil.....	256	5,842	6,098	4,833	1,265	-1,009	13,180	11,915
Miscellaneous.....	3	13	16	8	8	-5	843	835
Applications for mineral permits.....	38	293	331	310	21	+17	52,798	52,777
Applications for mineral leases.....	12	128	140	133	7	+5	1,460	1,453
Applications for patent, potassium.....	0	0	0	0	0	0	124	124
Federal Power Commission cases:								
Preliminary permits.....	11	41	52	40	12	-1	119	107
Licenses.....	0	3	3	3	0	0	28	28
Determinations under sec. 24.....	2	42	44	31	13	-11	269	256
Applications for classification as to power resources.....	7	15	22	13	9	-2	426	417
Applications for agricultural classification.....	18	155	173	116	57	-39	844	787
Applications for rights of way.....	35	177	212	195	17	+18	6,401	6,394
Irrigation-project reports.....	0	3	3	2	1	-1	914	913
Applications under enlarged-homestead acts.....	266	389	655	492	163	+108	57,198	57,085
Applications under stock-raising homestead acts.....	2,341	4,018	6,359	4,507	1,852	+489	130,235	128,383
Applications under ground-water reclamation act.....	39	15	54	48	6	+33	950	944
Indian Service requests for information.....	0	31	31	28	3	-3	9,542	9,539
	3,429	18,421	21,850	17,379	4,471	-1,042		

* Approximately.

SUMMARY OF FIELD OPERATIONS BY STATES

Alaska.—Expended \$10,000 through the Alaskan branch for supervision of 9 leases, 3 licenses, and 21 prospecting permits for coal and 1,022 prospecting permits for oil and gas. Coal produced, 121,825.20 tons; accrued rent and royalty, \$12,854.14. Supervised 1 power project.

Alabama.—Investigated the status of oil and gas prospecting operations throughout the State. Examined 5 tracts for mineral classification. Supervised 1 coal lease. Coal produced, 136,661 tons; accrued rent and royalty, \$13,666.10.

Arizona.—Examined 44 tracts for agricultural classification and made a special regional study for agricultural classification of the desert in the southwestern part of the State. Supervised 5 coal-prospecting permits, 2 sodium permits, 6 potassium permits, and 145 oil and gas permits involving public land. Investigated and reported on the value of 2 gold, 2 copper, 1 iron-ore, and 1 asbestos deposits, and supervised 5 vanadium leaseholds, 9 coal mines, and 219 oil and gas permits involving lands in 9 Indian reservations. Supervised 11 power projects.

Arkansas.—Supervised 2 prospecting permits for coal and 15 for oil and gas.

California.—Examined 54 tracts for agricultural classification. Investigated the oil-shale resources of 1 tract in Santa Barbara County and the sodium resources of parts of 2 townships in southeastern Kern County. Supervised on public land 191 leases and 519 prospecting permits for oil and gas, 4 leases for potassium, 6 prospecting permits for coal, 15 for sodium, and 1 for potassium. Oil produced, 10,729,586 barrels; natural gas, 13,090,399,000 cubic feet; natural-gas gasoline, 60,647,334 gallons; coal, 62 tons; sodium borate, 7,594 tons; sodium carbonate, 21,142 tons. Total rent and royalty accrued, \$1,034,629.91. Supervised on naval petroleum reserves 27 leases for oil and gas. Oil produced, 6,978,922 barrels; natural gas, 6,817,458,000 cubic feet; natural-gas gasoline, 25,567,986 gallons. Total rent and royalty accrued, \$1,612,167.05. Supervised 29 power projects.

Colorado.—Examined 136 tracts for agricultural classification, made regional studies of agricultural utility precedent to areal classification in the western part of the State, and published map showing such classifications in eastern and northwestern parts of the State. Examined 1 tract in Jackson County and 2 tracts in Grand County for oil and gas classification and 1 tract in Las Animas County for coal classification. Examined and mapped geologic structure in the Garcia field, Las Animas County, and in the Skull Creek district, Routt County. Supervised on public land 17 leases and 507 prospecting permits for oil and gas, 81 leases, 5 licenses, and 42 prospecting permits for coal, 2 prospecting permits for sodium, and 1 for potassium. Oil produced, 725,040 barrels; natural gas, 877,430,000 cubic feet; natural-gas gasoline, 14,642 gallons; coal, 434,871 tons. Total rent and royalty accrued, \$98,630.99. Supervised on tribal lands of the Ute Indians 1 lease for oil and gas, and inspected for the Indian Service 2 coal mines on the Southern Ute Reservation. Supervised 8 power projects.

Florida.—Investigated in the field the status of oil and gas prospecting operations throughout the State.

Idaho.—Examined 48 tracts for agricultural classification. Investigated storage and power possibilities on the South and Middle Forks of the Salmon River. Supervised 122 oil and gas prospecting permits, 8 coal permits, and 2 phosphate leases. Coal produced, 1,367 tons; phosphate rock, 22,101 tons. Total rent and royalty accrued, \$2,712.97. Supervised 5 power projects.

Louisiana.—Investigated the status of oil and gas prospecting and development throughout the State. Examined 1 tract for mineral classification. Supervised 12 leases and 8 prospecting permits for oil and gas. Oil produced, 9,963 barrels; natural gas, 498,234,000 cubic feet; natural-gas gasoline, 43,981 gallons. Total rent and royalty accrued, \$3,583.40.

Mississippi.—Investigated the status of oil and gas prospecting throughout the State. Examined 1 tract for mineral classification.

Montana.—Examined 171 tracts for agricultural classification. Investigated the stratigraphy and structure of parts of Toole, Teton, Chouteau, and Cascade Counties. Continued through the geologic branch detailed examinations in McCone, Richland, Dawson, Rosebud, Custer, and Powder River Counties for coal classification. Supervised on public land 74 leases and 570 prospecting permits for oil and gas; 51 leases, 17 licenses, and 17 prospecting permits for coal. Oil produced, 511,126 barrels; natural gas, 1,088,197,000 cubic feet; coal, 247,855 tons. Total rent and royalty accrued, \$100,988.67. Supervised on

Indian land 13 leases for oil and gas, 3 coal mines, 1 silver-lead leasehold, and 1 vermiculite leasehold. Supervised 25 power projects.

Nebraska.—Supervised 1 prospecting permit for oil and gas and 2 prospecting permits for potassium.

Nevada.—Examined 89 tracts for agricultural classification and made regional investigations of agricultural utility precedent to grazing classification in the northeastern part of the State. Supervised 114 prospecting permits for oil and gas, 6 prospecting permits for coal, 1 lease and 5 prospecting permits for sodium, and 1 lease for phosphate. Sodium sulphate produced, 586 tons. Total rent and royalty accrued, \$800. On Indian land investigated 3 silver-lead properties and 1 marl property. Supervised 6 power projects.

New Mexico.—Examined 24 tracts for agricultural classification. Continued through the geologic branch detailed examinations in McKinley and Sandoval Counties for coal classification. Supervised on public land 14 leases and 1,325 prospecting permits for oil and gas, 21 leases and 55 prospecting permits for coal, 3 leases and 43 prospecting permits for potassium, and 7 prospecting permits for sodium. Oil produced, 1,200,057 barrels; natural gas, 5,108,938,000 cubic feet; natural-gas gasoline, 3,089 gallons; coal, 74,858 tons. Total rent and royalty accrued, \$129,514.38. Supervised on Indian land 52 oil and gas leases and made technical investigation and report on 1 coal-mining operation in each of the Northern Navajo, Eastern Navajo, and Zuni Reservations. Supervised 3 power projects.

North Dakota.—Examined 7 tracts for agricultural classification. Supervised 58 leases, 4 licenses, and 4 prospecting permits for coal and 25 prospecting permits for oil and gas. Coal produced, 447,027 tons. Total rent and royalty accrued, \$28,490.14.

Oklahoma.—Examined 1 tract for agricultural classification. Continued in cooperation with the Oklahoma Geological Survey detailed geologic examination of the coal resources of the Stigler-Muskogee district, in Haskell and Muskogee Counties, begun in 1927. Supervised on public land 17 leases for oil and gas involving land in the bed of the Red River, Tillman County, and 16 prospecting permits for oil and gas. Oil produced, 450,342 barrels; natural-gas gasoline, 1,014,350 gallons. Total rent and royalty accrued, \$105,776.14. Supervised on Indian lands 10,128 leases for oil and gas involving 936,529 acres, 5,456 producing wells, and a combined rental, royalty, and bonus value of \$6,861,781.25; on segregated Choctaw and Chickasaw lands 65 leases for coal involving 59,849 acres, a production of 477,614 tons of coal, and a royalty value of \$41,103.32, and 1 lease for asphalt; on allotted restricted lands of Cherokee, Choctaw, and Creek Indians, 59 leases for coal involving a production of 67,729 tons and a royalty value of \$6,140.88, 3 leases for volcanic ash, and 1 for lead and zinc involving production with a royalty value of \$180; and on restricted Quapaw lands 50 departmental leases for lead and zinc involving 6,244 acres, a production of 144,805 tons of concentrates, and a royalty value of \$537,255.06.

Oregon.—Examined 41 tracts for agricultural classification. Supervised 14 prospecting permits for oil and gas, 2 leases and 4 prospecting permits for coal, 1 lease for oil shale, and 4 prospecting permits for potassium. Coal produced, 3,322 tons. Accrued rent and royalty, \$7,464.48. Supervised 2 power projects.

South Dakota.—Examined 3 tracts for agricultural classification. Supervised 22 prospecting permits for oil and gas and 2 leases for coal. Coal produced, 403 tons. Accrued rent and royalty, \$130.

Utah.—Examined 126 tracts for agricultural classification. Continued through the geologic branch investigation of the areal geology and structure of southern San Juan County and of the coal resources of eastern San Pete County. Supervised on public land 8 leases and 579 prospecting permits for oil and gas, 45 leases, 2 licenses, and 45 prospecting permits for coal, 17 prospecting permits for potassium, and 2 for sodium. Oil produced, 2,753 barrels; natural gas, 563,471,000 cubic feet; coal, 649,383 tons. Total rent and royalty accrued, \$195,546.36. Supervised 1 lease for oil and gas involving land in the Navajo Indian Reservation. Supervised 8 power projects.

Washington.—Examined 13 tracts for agricultural classification. Supervised 6 prospecting permits for oil and gas, 21 for coal, and 1 for sodium. Supervised 10 power projects.

Wyoming.—Examined 128 tracts for agricultural classification, and made regional investigations of agricultural utility precedent to areal classification in the southwestern part of the State. Collected representative samples of

shale formations in Wyoming for experimental tests. Remapped basal coal from Fort Steele westward and southward to the Colorado boundary to conform with certain township resurveys. Supervised on public lands 343 leases and 1,471 prospecting permits for oil and gas; 34 leases, 3 licenses, and 24 prospecting permits for coal; and 1 prospecting permit for potassium and 2 for sodium. Oil produced, 13,790,644 barrels; natural gas, 17,897,447,000 cubic feet; natural-gas gasoline, 39,746,906 gallons; coal, 914,932 tons. Total rent and royalty accrued, \$2,928,186.96. Supervised 43 leases for oil and gas involving tribal and allotted lands of the Shoshone Indians. Made periodic inspection and pressure test of wells shut in on Naval Petroleum Reserve No. 3 (Teapot dome). Supervised 3 power projects.

MINERAL-CLASSIFICATION DIVISION

The work of the mineral-classification division involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation relative to mineral classifications and to orders of withdrawal, modification, and restoration. The results of these field investigations take the form of reports concerning the mineral character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public land, Indian land, and naval oil reserves.

By departmental order the Geological Survey reports to the General Land Office on the prospective value for oil and gas of public lands involved in certain types of nonmineral entries and filings in Alabama, Kansas, Louisiana, Mississippi, Nebraska, Oklahoma, and Wyoming and in specified counties of Arizona, Arkansas, California, Colorado, Florida, Idaho, Michigan, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, and Washington, as a basis for the reservation or waiver of the Government's title to deposits of those minerals. During the fiscal year 5,660 requests for reports of this type were received, and reports on 4,430 cases were submitted to the General Land Office.

Little progress was made in 1930 in classifying the vast areas of public land that are still embraced in mineral withdrawals. The results accomplished include, however, net decreases of 58,126 acres in the total area of outstanding coal withdrawals, of 1,881 acres in the total area of outstanding petroleum withdrawals, and of 280 acres in the total area of outstanding phosphate reserves.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications, June 30, 1930, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash (with-drawn)
	With-drawn	Classified as coal land	With-drawn	Classified as oil land	With-drawn	Classified as oil-shale land	With-drawn	Classified as phosphate land	
Alaska		56,993							
Arizona	139,415		356						
Arkansas		61,160							
California	17,603	8,720	1,178,392						90,35
Colorado	4,142,233	3,082,272	217,116		64,560	952,239			
Florida							66,796	120	
Idaho	4,761	4,603					391,532	268,299	
Louisiana			466,990	4,233					
Montana	7,863,941	8,563,862	1,350,426	67,651			279,944	3,833	
Nevada	83,673				123				39,42
New Mexico	5,084,069	570,372							9,282,10
North Dakota	5,954,364	11,178,286	84,894						
Oregon	4,361	18,887							
South Dakota		250,093							
Utah	3,578,415	1,267,697	1,341,264		91,464	2,703,755	277,344	2,937	
Washington	691,801	141,444							
Wyoming	2,260,604	8,740,594	541,777			460,103	989,140	25,293	
	29,825,240	31,944,983	5,181,215	71,884	156,147	4,116,097	2,004,765	300,482	6,411,89

* Includes 3,151 acres of coal land reserved for use of the United States (Coal Reserve No. 1).

* Includes 2,078 acres of coal land reserved for use of the United States (Coal Reserve No. 2).

The following table summarizes the year's work to the extent that it involved technical reports on original applications for permit or lease rights on public lands:

Summary of applications under the mineral leasing acts, fiscal year 1930

Mineral	Prospecting permits				Leases			
	Pending July 1, 1929	Received during fiscal year	Acted on during fiscal year	Pending June 30, 1930	Pending July 1, 1929	Received during fiscal year	Acted on during fiscal year	Pending June 30, 1930
Oil and gas	13	106	102	17				
Coal	12	152	162	2	10	104	107	7
Phosphate					1	4	5	
Sodium	5	6	10	1	1		1	
Potassium	8	29	36	1		20	20	
Oil shale								
	38	293	310	21	12	128	133	7

Under the administrative policy initiated March 12, 1929, there have been submitted to the departmental committee "to pass on claims in connection with oil and gas permits" during the fiscal year 4,533 reports on oil and gas cases, outside Alaska, relative to the status of drilling operations initiated or completed on permit holdings or on the geologic structure affecting them, that had been held for cancellation or were involved in pending applications for extension of time, reinstatement, or assignment, and to the appraisal of geologic showings submitted in support of such applications.

In accordance with the duty delegated to the Geological Survey, definition of the "known geological structure" of one producing gas field was prepared and promulgated during the year—the Bowdoin

field, Montana; 210,041 acres; promulgated June 30, 1930. The net area included in outstanding definitions of the "known geological structure" of producing oil and gas fields on June 30, 1930, was 725,419 acres in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Geologic field work required in the solution of the problems of the division is performed in part by summer detail of Washington employees, in part by two division geologists with permanent headquarters in Denver, Colo., and in part by the geologic branch at the expense of the conservation branch. The work accomplished in 1929 is included in the branch summary of field operations by States beginning on page 57.

POWER DIVISION

The work of the power division consists primarily in obtaining and making available for use in the administration of the public-land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public land laws. The extent of this task is indicated by the fact that areas aggregating more than 6,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches. The field projects undertaken during the year are included in the branch summary of field operations by States (pp. 57-59.)

Copies of many of the reports on the power possibilities of the streams examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press. Manuscript reports on the water-power resources of the McKenzie River Basin, Oreg.; the Wynooche River Basin, the Stilaquamish River, Hall Creek, and the Sanpoil and Nespelem Rivers, Washington; and water utilization in the Boise River Basin, Idaho, were opened to public inspection during the year. A geologic report on proposed dam sites for flood control on the Skagit River, Washington, was prepared in cooperation with the geologic branch. Reports on the Green River and its utilization, the upper Colorado River and its utilization, and the water-power resources of the Umpqua River and its tributaries, prepared in cooperation with the water-resources branch, were published during the year.

Photolithographs showing river surveys were prepared in cooperation with the topographic branch as follows:

Plan and profile of Quillayute River, Bogachiel River to North Fork, Hoh River to mile 51, and South Fork of Hoh River, Wash.

Plan and profile of Soleduck River from mouth to Seven Lakes Basin, Lyre River from mouth to Crescent Lake, Deer Lake Reservoir, and Seven Lakes Basin, Wash.

Plan and profile of Quinault River from mouth to Rustler River and Qulpault Lake dam site, Wash.

Plan and profile of Hall Creek from mouth to mile 4 and dam sites on Sanpoil River, Wash.

Arrangements were made to obtain reports based on inspections in the field covering all power projects constructed under permits or grants from the Interior Department.

The work of the division is briefly summarized in the accompanying tables showing power-site reserves and outstanding water-resources withdrawals and classifications and in the general summary.

Pursuant to instructions of the Secretary of the Interior dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted by the Secretary since January 1, 1913, were called upon for detailed reports of the operation or development of their power systems during the calendar year 1929. The total installation of the reporting companies is 8,107,000 horsepower, of which 2,281,000 horsepower is installed at hydraulic plants. The total energy generated was 9,352,000,000 kilowatt-hours of which 7,414,000,000 kilowatt-hours was generated by water power. The energy generated increased 365,000,000 kilowatt-hours during the year.

Power output of permittees and grantees, 1916-1929

Calendar year	Kilowatt-hours	Increase or decrease		Calendar year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1916.....	1,200,000,000			1923.....	5,910,000,000	+963,000,000	+16
1917.....	2,000,000,000	+800,000,000	+67	1924.....	6,100,000,000	+190,000,000	+3
1918.....	3,200,000,000	+1,200,000,000	+60	1925.....	6,930,000,000	+830,000,000	+14
1919.....	3,100,000,000	-100,000,000	-3	1926.....	7,800,000,000	+870,000,000	+11
1920.....	4,300,000,000	+1,100,000,000	+35	1927.....	8,116,000,000	+316,000,000	+4
1921.....	3,725,000,000	-575,000,000	-13	1928.....	8,987,000,000	+871,000,000	+11
1922.....	4,947,000,000	+1,222,000,000	+33	1929.....	9,352,000,000	+365,000,000	+4

The following table shows the revenue accrued for occupancy and use of public lands by the foregoing power projects:

Accrued compensation for occupancy and use of lands under power permits and grants issued by the Interior Department, 1912-1930

State	1912-1915	1916-1920	1921-1925	1926-1930	1930
Alaska.....		\$6,960	\$0,280	\$2,900	\$580.00
Arizona.....	\$515	1,285	1,000	1,900	425.00
California.....	3,619	9,274	9,918	9,624	1,976.41
Colorado.....	315	875	1,765	1,465	240.00
Idaho.....	20	1,670	1,700	1,640	310.00
Montana.....	1,255	7,562	13,314	28,183	7,432.00
Nevada.....	281	2,245	2,570	3,565	1,470.50
New Mexico.....		20	60	275	60.00
Oregon.....	60	100	700	700	225.00
Utah.....		2,568	4,395	4,480	1,150.50
Washington.....	15	156	631	3,675	1,029.00
Wyoming.....		70	175	290	65.00
Minnesota.....		20	25	20	
Accumulation.....	6,080	32,805	46,433	58,097	14,963.45
	6,080	38,885	85,318	144,015	

Accrued charges for the unauthorized occupancy of public lands by power projects prior to the issuance of licenses therefor by the Federal Power Commission amount to \$76,437, of which \$37,260 is before the courts for adjudication.

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1929	Eliminated prior to July 1, 1929	Reserves outstanding prior to July 1, 1929	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1930
Alabama.....	2,377		2,377			2,377
Alaska.....	252,927	520	252,407	20,554		302,961
Arizona.....	1,296,356	124,027	1,172,329	42,363	15,817	1,198,875
Arkansas.....	29,671	360	29,311	3		29,314
California.....	1,436,875	33,280	1,403,595	19,513	5,842	1,417,266
Colorado.....	557,620	82,230	475,390	1,432	13,790	463,032
Florida.....	1,131		1,131			1,131
Idaho.....	610,703	191,534	419,169	41,993	9,677	451,485
Michigan.....	1,240		1,240			1,240
Minnesota.....	19,062	532	18,530			18,530
Mississippi.....	3		3			3
Montana.....	305,787	96,579	209,208	1,822	1,074	209,956
Nebraska.....	761		761			761
Nevada.....	359,215	480	358,735	98	1,365	357,468
New Mexico.....	270,927	11,243	259,684	2,053		261,737
Oregon.....	785,267	143,484	641,783	27,250	15,697	653,336
South Dakota.....	636		636			636
Utah.....	779,369	130,238	649,131	2,937	747	651,321
Washington.....	463,113	67,136	395,977	9,841	40,580	365,238
Wisconsin.....	1,906	226	1,680			1,680
Wyoming.....	232,777	76,284	156,493	43,025		199,518
	7,437,723	958,153	6,479,570	212,884	104,589	6,587,865

Summary of outstanding water-resources withdrawals and classifications June 30, 1930, in acres

State	Power reserves					Reservoir with- drawals	Public water reserves
	With- drawals	Classifica- tions	Designa- tions *	Miscella- neous	Total		
Alabama.....	120	1,735		522	2,377		
Alaska.....	93,415	114,425		95,121	302,961		
Arizona.....	374,452	50,599	524,212	249,612	1,198,875	23,040	20,740
Arkansas.....	21,994	1,590		5,730	29,314		
California.....	286,097	365,344		765,825	1,417,266	45,264	199,351
Colorado.....	211,929	194,717		56,386	463,032	1,728	9,646
Florida.....				1,131	1,131		
Idaho.....	197,629	236,041		17,815	451,485		15,417
Michigan.....	1,240				1,240		
Minnesota.....	12,309			6,221	18,530		
Mississippi.....				3	3		
Montana.....	129,284	55,547		25,145	209,956	9,080	9,697
Nebraska.....	761				761		
Nevada.....	26,627	85,405		245,436	357,468		14,841
New Mexico.....	118,527	49	143,161		261,737		10,196
North Dakota.....						1,091	
Oregon.....	340,009	209,764	15,250	88,313	653,336	18,608	26,901
South Dakota.....				636	636		240
Utah.....	441,592	175,574		34,155	651,321	80	35,230
Washington.....	98,979	193,897		72,362	365,238	31,797	920
Wisconsin.....				1,680	1,680		
Wyoming.....	79,953	77,563		42,002	199,518	1,714	84,145
	2,434,897	1,762,250	682,623	1,706,095	6,587,865	132,397	429,823

* Designated and not otherwise withdrawn.

AGRICULTURAL DIVISION

The functions of the agricultural division consist of the classification of lands under the enlarged-homestead law as nonirrigable; the classification of lands under the Nevada ground-water reclama-

tion law as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family; and the publication of areal-classification reports showing agricultural utility of lands in important public-land regions.

Classifications are made in accordance with the results of field examinations by the members of the division and with information obtained from other sources. The work of the division is planned with the primary purpose of acting on pending applications for classifications under the above-mentioned laws and to provide in advance the basis for appropriate action on new applications. The number of cases received and acted on during the fiscal year is shown in the general summary of cases (p. 56). There was a decrease of about 3 per cent in the number received, and the arrearage was 21 per cent less at the end of the year than at the end of the fiscal year 1929.

Summary of enlarged-homestead designations, in acres

[Areas classified as arid and nonirrigable, residence by entrymen required (act of Feb. 19, 1909 (35 Stat., 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat., 531), applicable to Idaho; act of June 13, 1912 (37 Stat., 132), applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat., 958), applicable to Kansas; act of Mar. 4, 1915 (38 Stat., 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (act of Feb. 19, 1909 (35 Stat., 639), applicable to Utah; act of June 17, 1910 (36 Stat., 531), applicable to Idaho)]

State	Designations prior to July 1, 1929	Cancellations prior to July 1, 1929	Designations outstanding prior to July 1, 1929	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1930
Arizona.....	31, 532, 704	5, 884, 314	25, 648, 390	680	7, 479, 675	18, 169, 395
California.....	13, 381, 433	240, 453	13, 140, 980	760	.....	13, 141, 740
Colorado.....	33, 972, 792	196, 428	33, 776, 364	3, 250	.....	33, 779, 614
Idaho:						
Total.....	13, 756, 316	461, 365	13, 294, 951	.....	40	13, 294, 911
Nonresidence.....	573, 227	4, 233	568, 994	.....	.....	568, 994
Kansas.....	651, 364	.....	651, 364	880	.....	652, 244
Montana.....	53, 487, 661	245, 728	53, 241, 933	7, 218	.....	53, 249, 151
Nevada.....	50, 218, 544	3, 580, 717	46, 637, 827	760	.....	46, 638, 387
New Mexico.....	43, 849, 007	227, 892	43, 621, 115	4, 429	.....	43, 625, 544
North Dakota.....	12, 280, 704	3, 848	12, 276, 856	823	.....	12, 277, 679
Oregon.....	21, 282, 311	989, 902	20, 292, 409	1, 440	.....	20, 293, 849
South Dakota.....	16, 342, 841	348, 170	15, 994, 671	500	.....	15, 995, 171
Utah:						
Total.....	11, 748, 070	1, 046, 317	10, 701, 753	6, 760	* 144, 290	10, 564, 223
Nonresidence.....	1, 650, 911	426, 713	1, 224, 198	5, 240	76, 170	1, 153, 268
Washington.....	6, 660, 452	251, 842	6, 408, 610	320	.....	6, 408, 930
Wyoming.....	29, 777, 106	162, 043	29, 615, 063	13, 075	.....	29, 628, 138
	338, 941, 305	13, 639, 019	325, 302, 286	40, 895	7, 624, 005	317, 719, 176

* 3,400 acres previously designated under sec. 1-5, now sec. 6.

Summary of stock-raising homestead designations, in acres

as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of which that 640 acres is reasonably required for the support of a family. Act of December 20, 1862.]

State	Designations prior to July 1, 1929	Cancellations prior to July 1, 1929	Designations outstanding prior to July 1, 1929	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1930
-----	14, 154, 873	887, 580	13, 267, 293	62, 386	135, 310	13, 194, 369
-----	1, 120		1, 120			1, 120
-----	8, 080, 375	3, 400	8, 026, 975	97, 590		8, 124, 565
-----	8, 872, 062	19, 840	8, 852, 222	330, 384	560	9, 182, 046
-----	480	480				
-----	5, 597, 010	1, 854	5, 695, 156	39, 517	40	5, 634, 633
-----	115, 779		115, 779			115, 779
-----	3, 491		3, 491			3, 491
-----				160		160
-----	15, 614, 375	17, 081	15, 597, 294	180, 358	160	15, 777, 492
-----	206, 161		206, 161	3, 038		209, 199
-----	596, 626	3, 120	593, 506	39, 462		632, 968
-----	31, 508, 166	636	31, 507, 530	127, 609	120	31, 635, 019
-----	383, 700		383, 700	15, 759		399, 459
-----	84, 918		84, 918	1, 516		86, 434
-----	6, 384, 446	3, 128	6, 381, 318	32, 030		6, 413, 348
-----	6, 519, 546	550	6, 518, 996	16, 787		6, 535, 783
-----	1, 938, 322	7, 800	1, 930, 522	134, 920	75	2, 065, 367
-----	694, 986	1, 174	693, 812	8, 049		701, 561
-----	20, 514, 241	7, 173	20, 507, 068	326, 609	480	20, 833, 197
-----	121, 220, 377	953, 816	120, 266, 561	1, 416, 174	136, 745	121, 545, 990

market order of withdrawal creating Public Water Reserve which received Executive approval April 17, 1926, every smallest division of the public-land surveys which is vacant unpatented public land and contains a spring or water hole and within a quarter of a mile of every spring or water hole on unsurveyed public land were reserved for public use and in pending legislation. This order obviated the necessity for withdrawals of specific tracts containing springs or water available for stock watering, but it requires a determination as to all entries of public land whether or not any of the entries involved are in fact affected by it. On the basis of such determination orders of interpretation are issued from time to time by legal subdivisions of the public-land survey any tracts which contain a water supply affected by the order. New withdrawals of this type are made to reserve lands along streams and made from time to time for special public purposes. The outstanding reserves of this type and of current action on them is shown in the following table:

Public water reserves, in acres

	Reserved prior to July 1, 1929	Eliminated prior to July 1, 1929	Reserves outstanding July 1, 1929	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1930
-----	21, 782	2, 367	19, 425	1, 565	250	20, 740
-----	206, 644	7, 138	199, 506	365	520	199, 351
-----	7, 900	360	7, 540	2, 245	140	9, 645
-----	14, 755	410	14, 345	1, 072		15, 417
-----	10, 249	1, 232	9, 017	9, 840	160	9, 697
-----	15, 831	3, 260	12, 571	2, 240		14, 811
-----	11, 521	520	11, 001	880	1, 685	10, 196
-----	27, 229	1, 288	25, 941	900		26, 801
-----	240		240			240
-----	43, 566	7, 596	35, 970	2, 280		38, 230
-----	920		920			920
-----	96, 485	14, 060	82, 425	1, 800	80	84, 145
-----	456, 642	33, 211	418, 431	14, 227	2, 835	429, 823

In the field broad areal studies were continued in the Colorado Basin region in southwestern Colorado and southwestern Wyoming, and a land-classification map of northwestern Colorado was published. A reconnaissance report including a series of maps for the 10 principal public-land States was prepared for the information of the President's committee on the conservation and administration of the public domain.

During the fiscal year the area designated under the Nevada ground-water reclamation act was increased 24,080 acres, to a total of 1,643,295 acres. Outstanding withdrawals, aggregating 11,530 acres, under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

MINERAL-LEASING DIVISION

EARLY LEASING

The earliest suggestion of mineral leasing on the public domain was contained in the ordinance of May 20, 1785, whereby Congress ordered "that there shall be reserved one-third part of all gold, silver, lead, and copper mines to be sold or otherwise disposed of as Congress shall hereafter direct." The supervision was assigned to the War Department. The phrasing of this clause follows the reservations made in some of the Crown charters and suggests a doubt as to the policy of disposal to be adopted. This was probably due to the fact that the mineral resources of the country were practically unknown then, as only small amounts of gold and lead had been found in a few of the Southern States, and not on the public domain but on privately owned lands.

On March 3, 1807, Congress provided for the leasing of "any lead mine which has been or may hereafter be discovered in the Indiana territory, for a time not exceeding five years." This attempt at mineral leasing on the public domain was not a success, as the cost of supervision had far exceeded the income. The acts of July 11, 1846, and March 4, 1847, abolished all mineral leases and established sales, and the act of 1849 transferred the charge of such mineral lands from the War Department to the Department of the Interior. In the preemption act of 1841 it was provided "no lands on which are situated any known salines or mines shall be liable to entry under and by virtue of the provisions of this act." In 1876 the Attorney General of the United States held that "salines, gold, silver, lead, and copper mines" were reserved for the "future disposal of Congress."

DEVELOPMENT OF PRESENT MINERAL LEASING

The act of March 3, 1909, authorized the reservation of coal deposits. The act of June 25, 1910, authorized the withdrawal of public lands for specific purposes, including the reservation of coal, oil, gas, and phosphate.

The acts of June 22, 1910, August 24, 1912, and July 17, 1924, provided for agricultural entry on public lands but withheld certain minerals. On August 1, 1912, Congress by joint resolution ordered

certain coal lands in Wyoming, on which there was an operating coal mine, leased to the then operating company. This lease became effective August 29, 1912. On October 20, 1914, a law providing for the leasing of coal lands in Alaska became effective. The law of August 11, 1916, applied only to the leasing of mineral lands acquired under the so-called Weeks law of March 1, 1911. The act of October 2, 1917, was a war measure and applied only to potash.

The general mineral leasing act of February 25, 1920, provided for leasing oil, gas, coal, sodium, oil shale, and phosphate lands on the public domain and oil and gas lands in Alaska. The act of March 4, 1923, provided for leasing oil and gas lands in the Red River, Okla. The law of April 17, 1926, provided for leasing gold, silver, and quicksilver deposits on certain patented lands acquired from Mexico, and the law of June 8, 1926, covered leasing for sulphur in Louisiana. The act of February 7, 1927, repealed the act of October 2, 1917, and extended potash leasing. The act of December 11, 1928, provided for sodium development, and the act of May 21, 1930, for leasing for oil and gas in or under railroads or other rights of way.

BENEFITS DERIVED FROM MINERAL LEASES

The conservation of natural resources has been the outstanding feature of the mineral-leasing program. Such legislation, including prevention of waste and economy in development and production, can only tend toward the ultimate protection of our undeveloped mineral deposits. Since the act of October 2, 1914, \$66,001,615.48 has accrued from royalties, rentals, and bonuses. At the end of the fiscal year 1930 there were in effect 992 leases, 6,846 permits, and 34 licenses involving mineral deposits on public land in 19 States and Alaska.

Under the act of 1920 the public-land States receive, without expense, 37.5 per cent of all money derived from leases and permits within their respective borders and participate in the benefits resulting from the expenditure of an additional 52.5 per cent of the income by the Bureau of Reclamation. Incidental benefits include taxes on production and on property used in the development of leases, which in some States amount to more than one-fifth of the total income. Only 10 per cent of the money received from such leasing operations is retained in the United States Treasury for supervision, which, however, has cost only 3.7 per cent of the total income.

Alaska, by special legislation, receives all net profits from the operations of Government mines and all royalties and rentals derived from mineral leases. The money thus derived is applied to the reimbursement of the Federal Government for the construction of railroads in that Territory.

WORK OF MINERAL-LEASING DIVISION

The work of the mineral-leasing division is supervisory (both inspectional and regulatory) with respect to operations on the public domain for the discovery and development of petroleum, natural gas, oil shale, coal, phosphate, sodium, potassium, and sulphur; on certain land grants for gold, silver, and mercury; on naval petroleum

reserves for petroleum and natural gas; and on Indian lands for coal oil and gas, zinc, lead, iron, silver-lead, uranium, vanadium, and radium ores, vermiculite, asbestos, asphalt, volcanic ash, and stone. This work is conducted with a minimum of administrative supervision from Washington by means of district offices at or near the primary centers of mining or drilling activities, under the direction of responsible engineers who have full authority to represent the Secretary within their jurisdiction and to order compliance with the law and regulations under which operations are conducted.

PREVENTION OF ACCIDENTS

Many improvements in mining practice, as well as the prevention of both major and minor accidents, result from the careful work of the supervisors of the division. During the year in six States having a combined production of more than 435,000 tons of coal there were no fatal accidents whatever. In Montana there have been no fatal accidents on leased public coal lands since the inception of coal leasing in 1920—more than 1,450,000 tons of coal produced without a fatal accident and with less than 100 minor accidents. In the nine States where there are coal mines on both private land and leased public and Indian land the fatalities per million tons of coal mined were about 20 per cent less in the leased coal mines under the supervision of the engineers of the division than in the private mines.

One zinc mine on leased Indian lands has been worked for more than two years and a half without a "time-lost" accident. At this mine from 40 to 80 men are employed at four different shafts. The record for all the Indian zinc mines in this district under supervision was more than 700,000 tons of ore to the fatality, or less than 1.5 fatalities for each million tons of ore mined.

ACTIVITIES ON THE PUBLIC DOMAIN

Supervision of publicly owned mineral deposits was increased during the fiscal year 1930 by the issuance of leases, licenses, and prospecting permits as follows:

Leases, licenses, and permits issued, fiscal year 1930

	Number	Acres		Number	Acres
Leases:			Permits:		
Oil and gas.....	88	36,067.69	Oil and gas.....	181	323,762.66
Coal.....	29	9,311.87	Coal.....	68	72,098.22
Potash.....	3	7,674.89	Potassium.....	41	67,842.79
Licenses: Coal.....	15	638.53	Sodium.....	30	42,590.90

During the same period supervisory work was decreased by the cancellation of 11 coal leases, 11 coal permits, 22 potash permits, 2 sodium permits, 8 oil and gas leases, and 9,141 oil and gas permits, a total of 9,195 cancellations, and the expiration of 20 coal permits and licenses, 53 potash permits, and 16 sodium permits—a grand total of 10,184, compared with the total of 8,758 cancellations for the fiscal year 1929.

The following table shows the total number of leases, licenses, and permits in effect at the end of the fiscal year:

Mineral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey June 30, 1930

State	Coal						Oil and gas	
	Leases		Permits		Licenses		Leases (number)	Permits (number)
	Number	Acres	Number	Acres	Number	Acres		
Alaska.....	9	11,987.28	21	29,362.64	3	30.00		1,022
Alabama.....	1	1,840.00						
Arizona.....			5	11,520.00				145
Arkansas.....			1	2,079.88				15
California.....			6	8,335.29			• 191	519
Colorado.....	81	12,751.05	42	27,642.20	5	200.00	17	507
Idaho.....			8	9,137.17				122
Kansas.....								
Louisiana.....							12	• 8
Montana.....	51	5,768.17	17	8,201.26	17	674.89	74	570
Nebraska.....								1
Nevada.....			6	10,385.92				114
New Mexico.....	21	14,703.38	55	88,550.97			14	1,326
North Dakota.....	58	6,536.86	4	520.46	4	159.93		25
Oklahoma.....							17	10
Red River.....								6
Oregon.....	2	1,895.24	4	2,040.00				14
South Dakota.....	2	119.04						22
Utah.....	45	32,681.57	45	53,385.67	2	160.00	8	579
Washington.....			21	18,422.33				6
Wyoming.....	34	15,036.46	24	23,113.64	3	120.00	343	1,471
	304	103,319.05	259	292,697.43	34	1,344.82	576	6,462

State	Sodium				Potash			
	Leases		Permits		Leases		Permits	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Arizona.....			2	2,398.74				
California.....			15	24,342.44	• 4	7,783.80	1	2,560.00
Colorado.....			2	2,160.00				
Idaho.....								
Nebraska.....							2	390.00
Nevada.....	1	1,440.00	5	9,409.37				
New Mexico.....			7	13,204.33			• 2	4,560.00
Do.....					3	7,674.39	41	81,317.09
North Dakota.....			3	524.83				
Oregon.....							4	5,920.00
Utah.....							17	24,321.33
Washington.....			1	40.00				
Wyoming.....			2	1,045.78			1	1,760.00
	1	1,440.00	37	53,125.49	7	15,458.19	68	120,828.42

• Includes 15 leases on Naval Petroleum Reserves Nos. 1 and 2 under the act of Feb. 25, 1920, and 10 on Naval Petroleum Reserves Nos. 1 and 2 under the act of Oct. 2, 1917.

• Oil and gas permits in Louisiana include the right to lease sulphur deposits discovered while prospecting for oil and gas.

• Under the act of Oct. 2, 1917.

Also Idaho, 2 phosphate leases, 1,700 acres; Nevada, 1 phosphate lease, 160 acres; Oregon, 1 oil-shale lease, 2,680 acres. Total leases, 992; licenses, 34; permits, 6,846; grand total, 7,872.

PRODUCTION

Coal.—During the year, 3,033,075.88 tons of coal was produced in 12 States, from which there accrued \$489,616.32 in rents, royalties, and bonuses; this was a decrease in production of 4 per cent from the preceding year. Prospecting in the San Pete Valley of Utah revealed coal at a depth of 1,000 feet below the surface. It is estimated that more than 5,000,000 tons of coal was conserved in Utah alone by influencing coal operators to mine the upper beds before attacking the lower beds. Similar work was done in other States, particularly

in Wyoming, where changes suggested by the supervisors have increased the ultimate recovery of coal at least 10 per cent and also the amount of lump coal produced. The new equipment at the open-pit mine of the Northwestern Improvement Co. at Colstrip, Mont., will result in considerable saving of coal owing to the greater depth of overburden handled and the corresponding increase in the width of cuts, with fewer supporting coal walls.

Potash.—No potash was produced during the fiscal year 1930, but prospecting was continued in the Utah and New Mexico districts. In Utah 750 feet of drilling was completed to check potash deposits noted while drilling for oil. A shaft was started on the New Mexico potash leases and sunk to a depth of 380 feet by the end of the year. A potash prospecting permit was issued on land in the vicinity of Alliance, Nebr., near which considerable potash was produced during the World War.

Sodium, etc.—The potash leases in California produced 7,594.47 tons of borax and 21,142 tons of soda ash. The only sodium lease in effect produced 585.59 tons of anhydrous sodium sulphate. There were, however, 37 sodium prospecting permits in effect.

Phosphate.—Only three phosphate leases were in effect at the end of the year, and only one of them in Idaho had any production. On this lease 22,100.65 tons of ore was mined, an increase of 1.6 per cent over the output of 1929 and of 6,339.6 per cent over that of 1926.

Oil and gas.—The production of oil and gas on public lands in the fiscal year 1930 showed the following increases over 1929: Crude oil, 4,960,667 barrels, or 22 per cent; natural gas, 16,353,721,890 cubic feet, or 72 per cent; natural gasoline, 54,087,427 gallons, or 114 per cent. Income from royalties increased as follows: Crude oil, \$372,470, or 11 per cent; natural gas, \$47,866, or 38 per cent; natural gasoline, \$47,926, or 41 per cent. The unit price per barrel of crude oil, based on royalty values, declined from \$1.18 in 1929 to 80 cents in 1930; and the unit price per M cubic feet of natural gas declined almost 1 cent.

Coal produced from leases, licenses, and permits on public lands, in tons, by fiscal years

State	1912-1925	1926-1928	1929	1930	Total
Alaska.....	455,497.43	297,943.54	107,971.62	121,825.20	983,237.79
Alabama.....		76,433.00	109,832.00	136,661.00	322,926.00
California.....		6.00	36.00	62.00	104.00
Colorado.....	2,028,940.29	1,241,636.10	490,446.22	434,871.08	4,195,893.69
Idaho.....			466.65	1,366.65	1,833.30
Montana.....	252,973.58	756,384.96	299,813.84	247,854.94	1,557,027.32
Nevada.....		91.15			91.15
New Mexico.....	74,427.26	197,829.99	84,441.64	74,857.99	431,556.88
North Dakota.....	453,696.38	783,530.62	462,285.16	447,627.36	2,147,138.52
Oregon.....	688.97	2,332.49	3,234.47	3,231.70	9,487.63
South Dakota.....	1,842.63	2,027.79	342.45	402.58	4,615.45
Utah.....	487,303.62	887,706.12	580,100.78	649,383.27	2,604,493.79
Washington.....	164,280.43	81,606.60			245,887.03
Wyoming.....	4,466,885.23	3,200,185.52	1,022,860.90	914,932.11	9,603,863.76
	8,385,534.82	7,527,715.88	3,161,831.73	3,033,076.88	22,108,158.31

Sodium salts produced from public lands, in tons, by fiscal years

State	1921-1925	1926-1928	1929	1930	Total
California.....	3,145.30	21,719.43	22,906.47	28,736.47	76,507.67
Nevada.....	248.25	1,286.06	674.43	585.69	2,794.33
	3,393.55	23,005.49	23,580.90	29,322.06	79,302.00

Phosphate produced from public lands, in tons, by fiscal years

State	1921-1925	1926-1928	1929	1930	Total
Idaho.....	6, 132. 44	47, 657. 76	21, 746. 61	22, 100. 65	97, 637. 46
Nevada.....			45. 45		45. 45
	6, 132. 44	47, 657. 76	21, 792. 06	22, 100. 65	97, 682. 91

Operating mines, fiscal year 1930

	Coal		Potash	Sodium	Phosphate
	Shipping	Wagon			
Alaska.....	4	1			
Alabama.....	1				
California.....		1	2		
Colorado.....	15	49			
Idaho.....		3			2
Montana.....	2	68			
Nevada.....				1	1
New Mexico.....	8	12			
North Dakota.....	6	53			
Oregon.....	1	2			
South Dakota.....		2			
Utah.....	22	26			
Wyoming.....	23	150			
	82	367	2	1	3

*Petroleum, natural gas, and natural-gas gasoline produced from public lands, by fiscal years***1930, by States**

	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)
California.....	10, 729, 585. 87	13, 090, 399. 00	60, 647, 334. 00
Colorado.....	725, 039. 54	877, 430. 00	14, 642. 00
Louisiana.....	9, 963. 41	498, 224. 00	43, 980. 76
Montana.....	511, 125. 69	1, 068, 197. 00	
New Mexico.....	1, 200, 056. 51	5, 108, 938. 00	3, 088. 89
Oklahoma.....	450, 342. 03		1, 014, 349. 68
Utah.....	2, 752. 49	563, 471. 00	
Wyoming.....	13, 790, 643. 81	17, 897, 447. 00	39, 746, 908. 00
	27, 419, 509. 35	39, 124, 116. 00	101, 470, 301. 33

Total

	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)
1921-1925.....	118, 333, 954. 01	60, 296, 796. 00	63, 997, 718. 97
1926.....	29, 712, 876. 16	18, 535, 880. 50	35, 910, 791. 54
1927.....	25, 648, 101. 43	17, 723, 410. 03	40, 104, 404. 57
1928.....	23, 370, 549. 38	18, 922, 026. 00	39, 698, 292. 83
1929.....	22, 458, 842. 62	22, 770, 394. 11	47, 319, 874. 32
1930.....	27, 419, 509. 35	39, 124, 116. 00	101, 470, 301. 33
	246, 943, 832. 95	177, 374, 622. 64	328, 501, 383. 55

ROYALTY, RENT, AND BONUSES

The following tables summarize accrued income from all mineral leases, licenses, and prospecting permits under the various leasing acts applicable to the public lands:

Royalties, rentals, and bonuses accrued from all mineral operations on public lands, by fiscal years

State	1912-1925	1926-1928	1929	1930	Total
Alabama.....	\$86,380.00	\$7,643.30	\$10,983.20	\$13,666.10	\$118,672.60
Alaska.....	35,142.42	40,050.32	13,162.60	12,854.14	101,209.48
California.....	4,676,746.55	3,582,191.85	677,743.16	1,034,629.91	9,971,311.47
Colorado.....	216,853.81	343,000.85	106,832.87	98,639.99	765,327.52
Idaho.....	1,111.38	5,774.26	2,885.14	2,712.97	11,983.75
Louisiana.....	1,506.59	21,492.65	10,723.06	3,583.40	37,307.70
Montana.....	891,278.79	635,985.39	110,554.70	100,988.67	1,738,807.55
Nevada.....	301.07	5,062.79	1,480.00	800.00	7,643.86
New Mexico.....	13,883.64	60,504.86	50,978.45	129,514.38	254,881.33
North Dakota.....	29,144.79	57,838.52	24,763.89	28,490.14	140,237.34
Oklahoma.....	.....	376,617.12	114,160.27	105,776.14	596,553.53
Oregon.....	982.15	2,968.80	1,187.10	7,464.48	12,572.53
South Dakota.....	399.60	311.52	80.00	130.00	921.12
Utah.....	138,932.03	238,292.09	112,271.36	195,546.36	685,041.84
Washington.....	22,215.91	8,312.83	.....	.....	30,528.74
Wyoming.....	31,206,133.17	14,533,531.33	2,862,763.66	2,926,186.96	51,528,615.12
	37,320,983.90	19,919,578.48	4,100,069.46	4,660,983.64	66,001,615.48

Royalties, rentals, and bonuses accrued from mining operations on public lands, by fiscal years

	Coal	Sodium	Phosphate	Potash	Oil shale	Bonuses	Total
1930							
Alabama.....	\$13,666.10	.....	.....	.....	.....	.....	\$13,666.10
Alaska.....	12,854.14	.....	.....	.....	.....	.....	12,854.14
California.....	15.50	.....	.....	\$16,216.40	.....	.....	16,231.90
Colorado.....	55,623.86	.....	.....	.....	.....	.....	55,623.86
Idaho.....	341.66	.....	\$2,371.31	.....	.....	.....	2,712.97
Montana.....	26,400.16	.....	.....	.....	.....	\$100.00	26,500.16
Nevada.....	.....	\$720.00	80.00	.....	.....	.....	800.00
New Mexico.....	13,510.37	.....	.....	1,919.00	.....	10.00	15,439.37
North Dakota.....	28,487.14	.....	.....	.....	.....	3.00	28,490.14
Oregon.....	8,124.48	.....	.....	.....	\$1,340.00	.....	7,464.48
South Dakota.....	130.00	.....	.....	.....	.....	.....	130.00
Utah.....	193,733.26	.....	.....	.....	.....	.....	193,733.26
Wyoming.....	138,729.65	.....	.....	.....	.....	.....	138,729.65
SUMMARY	489,616.32	720.00	2,451.31	18,135.40	1,340.00	113.00	512,376.03
1912-1925.....	790,408.19	301.07	1,111.38	24,458.65	.....	148,384.00	964,663.29
1926.....	319,626.78	2,160.00	695.00	6,031.78	.....	1,566.00	330,079.56
1927.....	322,308.12	1,440.00	2,549.41	6,217.60	.....	1,237.00	333,752.13
1928.....	372,949.85	1,440.00	2,529.85	9,402.40	.....	1,095.00	387,417.10
1929.....	397,964.30	720.00	2,308.48	11,989.33	.....	484.00	414,186.11
1930.....	489,616.32	720.00	2,451.31	18,135.40	1,340.00	113.00	512,376.03
	2,662,878.56	6,781.07	11,645.43	76,235.16	1,340.00	152,879.00	2,941,754.22

CONSERVATION BRANCH

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*Royalties and bonuses accrued from oil and gas operations on public lands, by
fiscal years*

1930, by States

	Petroleum	Natural gas	Gasoline	Bonuses	Total
California.....	\$917, 449. 12	\$40, 845. 05	\$80, 603. 84	-----	\$1, 018, 898. 01
Colorado.....	40, 408. 58	2, 593. 38	19. 17	-----	43, 016. 13
Louisiana.....	1, 700. 71	1, 726. 69	156. 00	-----	3, 583. 40
Montana.....	69, 376. 05	3, 657. 45	-----	\$1, 455. 00	74, 488. 51
New Mexico.....	86, 069. 26	27, 990. 59	15. 16	-----	114, 075. 01
Oklahoma.....	102, 303. 10	-----	3, 473. 04	-----	105, 776. 14
Utah.....	379. 87	1, 433. 23	-----	-----	1, 813. 10
Wyoming.....	2, 592, 265. 89	95, 132. 39	99, 913. 83	145. 20	2, 787, 457. 31
	3, 809, 947. 58	172, 878. 79	164, 181. 04	1, 600. 20	4, 148, 607. 61

Total

	Petroleum	Natural gas	Gasoline	Bonuses	Total
1921-1925.....	\$32, 938, 494. 47	\$398, 543. 30	\$251, 197. 70	\$2, 768, 085. 14	\$36, 356, 320. 61
1926.....	7, 951, 665. 52	93, 508. 29	154, 265. 43	250, 503. 94	8, 449, 943. 18
1927.....	5, 741, 485. 97	91, 796. 54	173, 172. 59	3, 980. 00	6, 010, 435. 10
1928.....	3, 519, 810. 55	108, 570. 86	107, 070. 00	672, 500. 00	4, 407, 951. 41
1929.....	3, 437, 477. 58	125, 013. 01	116, 254. 69	7, 138. 07	3, 685, 883. 35
1930.....	3, 809, 947. 58	172, 878. 79	164, 181. 04	1, 600. 20	4, 148, 607. 61
	57, 398, 881. 67	990, 310. 79	966, 141. 45	3, 703, 807. 35	63, 059, 141. 26

ACTIVITIES ON NAVAL PETROLEUM RESERVES

Production from Naval Petroleum Reserve No. 3, in Wyoming, was definitely suspended December 31, 1927, and the total royalty accrued from 1923 to date of suspension of production amounted to \$848,947.91. Supervision on this reserve for the present is confined to observation of gas pressure and consultation with the Navy Department.

Royalties accrued from naval petroleum reserves in California during the fiscal year were as follows: Petroleum, \$1,369,861.43; natural gas, \$77,029.07; gasoline, \$165,276.55. The total receipts from these reserves for the fiscal years 1921 to 1930 amounted to \$23,062,196.73.

Petroleum, natural gas, and gasoline produced from naval reserves

	Fiscal year	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)
California.....	1921-1925	37, 862, 945. 09	35, 544, 349. 81	34, 508, 751. 07
	1926	12, 234, 702. 16	12, 617, 265. 09	19, 851, 282. 68
	1927	12, 368, 315. 70	12, 328, 208. 69	24, 052, 402. 12
	1928	9, 690, 573. 93	9, 077, 966. 68	24, 797, 263. 61
	1929	8, 116, 635. 98	7, 711, 858. 00	24, 908, 262. 82
	1930	6, 978, 922. 16	6, 817, 458. 00	26, 567, 986. 00
		87, 272, 095. 02	84, 397, 096. 27	153, 685, 948. 30
Wyoming.....	1923-1925	2, 533, 213. 05	950, 520. 00	7, 829. 00
	1926	320, 680. 00	1, 453, 032. 00	291, 852. 00
	1927	857, 049. 32	1, 958, 468. 00	1, 441, 036. 00
	1928	149, 285. 26	796, 864. 00	743, 179. 00
		3, 550, 227. 63	5, 162, 869. 00	2, 483, 896. 00
Total.....	1921-1925	40, 406, 158. 14	36, 494, 869. 81	34, 516, 580. 07
	1926	12, 755, 382. 16	14, 375, 287. 09	20, 143, 134. 68
	1927	12, 725, 365. 02	14, 286, 671. 69	25, 493, 438. 12
	1928	9, 839, 859. 19	9, 873, 820. 68	25, 540, 442. 61
	1929	8, 116, 635. 98	7, 711, 858. 00	24, 908, 262. 82
	1930	6, 978, 922. 16	6, 817, 458. 00	26, 567, 986. 00
		90, 822, 322. 65	89, 559, 965. 27	158, 169, 844. 30

ACTIVITIES ON INDIAN LANDS

Cooperation with the Indian Service during the fiscal year included technical supervision over all mining and drilling operations on tribal, segregated, restricted allotted, and Indian lands set aside by Executive order. This work involved the enforcement of lease terms and operating regulation, technical investigations and advice concerning impairment of mineral deposits and the adequacy of bonus, appraisal of unleased land subject to mineral development, determination of damage to surface improvements, investigations of domestic water supply contaminated by waste from mineral development, and engineering and geologic reports on leased and unleased lands subject to mineral development. Field offices for the performance of these duties were maintained at Miami, McAlester, Muskogee, Oklahoma City, Red River, Shawnee, and Tulsa, Okla.; Billings and Shelby, Mont.; Farmington, N. Mex.; Thermopolis, Wyo.; and Denver, Colo.

In the following summary only outstanding features of economic importance are mentioned:

ARIZONA

Colorado River Reservation: 1 gold lease.

Fort Apache Reservation: 1 application for iron-ore lease, 1 agency coal mine, and 1 asbestos lease.

Hopi Indian Reservation: 2 agency coal mines.

Northern Navajo Reservation: 5 vanadium leases and 1 agency coal mine.

Southern Navajo Reservation: 3 agency coal mines.

Western Navajo Reservation: 2 agency coal mines.

San Carlos Reservation: 2 asbestos leases and 2 copper leases.

Gila River Reservation: 1 gold prospect.

Pima Reservation: 1 application for mineral lease.

Fort Apache Indian Reservation: An engineering and geologic examination of the deposits of iron ore under mineral location in the western part leads to the conclusion that there is awaiting development not less than 10,000,000 tons of high-grade iron ore having a high potential royalty value to the Indians. There are two abandoned wells on Navajo tribal lands and one on Navajo Executive order lands.

COLORADO

Southern Ute Reservation: 2 agency coal mines. Coal and mineral supervision on the ceded Ute lands included 40 coal lenses, 5,418.54 acres; 1 coal license, 40 acres; 13 coal permits, 8,139.65 acres; 1 awarded coal-lease application, 2,160 acres; and 1 potash permit, 2,538.67 acres, from which a total of \$11,729 in royalties and rentals was credited to the account of the Indians.

The status of oil and gas wells on Indian lands in Colorado is as follows: Ute tribal lands, active wells, 6 oil, 2 gas; shut in, 4 oil, 2 gas; abandonment, 13. Ute allotted lands, abandoned, 1. The oil and gas supervision included one producing lease, one producing permit, and one nonproducing lease. In addition, two nonproducing leases embrace both ceded Ute and public lands. Operation of 12 wells has been indefinitely suspended, and 3 wells are in the process of drilling. On the Southern Ute Indian Reservation the Durango Natural Gas Co. delivered to consumers 206,000,000 cubic feet of natural gas from the Ute dome gas field during its initial year of operation.

MONTANA

Rocky Boy Reservation: 1 application for vermiculite lead-silver lease, 1 silver-lead ore lease, and 1 coal prospect. Crow Reservation: 2 agency coal mines. During one of the examinations by the district mining supervisor a deposit of vermiculite was discovered on the lands included in a silver-lead lease, and considerable royalty returns are expected. The status of oil and gas wells on Crow Indian lands in Montana is as follows: Crow allotted lands,

shut in, 3 oil; abandoned, 11; plugged and abandoned, 1. Crow tribal lands, shut in, 2 oil; abandoned, 5. Private, drilling wells, active 9, suspended 102; producing wells, active, 47 (6 oil, 41 gas), shut in, 106 (8 oil, 98 gas); abandoned, 260; plugged and abandoned, 38. Recommendations were made for offering certain oil and gas tribal lands for lease with appraisals of their value for bonus purposes; operating equipment at the sites of two existing oil wells was appraised. The status of oil and gas wells on Blackfeet Indian lands in Montana is as follows: Indian, drilling wells, suspended, 1; plugged and abandoned, 2. Private, drilling wells, active, 27, suspended, 31; producing wells, active, 1,243 (1,102 oil, 141 gas), shut in, 90 gas; abandoned, 824. Engineering report and advice were given in a controversy over the selection of an oil-well site.

NEVADA

Pyramid Lake Indian Reservation: 3 silver-lead leases, 1 application for marl lease.

NEW MEXICO

Eastern Navajo Indian Reservation: 1 agency coal mine.

Northern Navajo Indian Reservation: 1 agency coal mine, 1 coal lease.

Zufi Indian Reservation: 1 agency coal mine.

The status of oil and gas wells on Indian lands in New Mexico is as follows: Navajo tribal lands, producing wells, active, 28 oil; shut in, 2 oil; abandoned, 14. Navajo allotted lands, producing wells shut in, 6 oil; Navajo Executive order, abandoned, 1.

OKLAHOMA

Five Civilized Tribes: The McAlester office maintains general technical supervision over all mining operations on segregated and restricted allotted leases on Indian coal and mineral lands in Oklahoma, exclusive of Ottawa County. Cooperation with and engineering assistance to lessees resulted in improved methods of mining, thus increasing the returns on a number of the segregated leases.

During the last two years six companies have introduced the slope panel system of mining in their mines. The Kali Inla Coal Co., at Cambria, has introduced and is operating the panel-long-wall advancing system and is controlling the caving of the roof by means of collapsible jacks. The system provides for a 100 per cent recovery of the area worked and is proving very satisfactory.

The Missouri, Kansas & Texas Coal Co. continues successfully to draw pillars in its No. 19 mine at Wilburton. The drawing of pillars is an innovation in Oklahoma mining, as heretofore it was considered impracticable. However, 188,402 tons of pillar coal has been produced from this mine by this method and has netted the Choctaw and Chickasaw Indian Nations \$15,000 in royalties, which would have been lost had the lessee been permitted to abandon the property without drawing pillars.

A fire was extinguished in an opening on the outcrop of the Craig Coal Mining Co.'s lease No. 2, Pittsburg County.

The 396,386.28 acres of segregated coal lands belonging to the Choctaw and Chickasaw Indian Nations have decreased in value to a marked degree during the last 15 years. This has been due largely to the discovery of new coal deposits and the development of oil and gas in the State, which have changed completely the fuel situation in Oklahoma. All the railroads that traverse the State, with the exception of the Chicago, Rock Island & Pacific, which has its own mines, and the Missouri, Kansas & Texas, are using fuel oil in their locomotives. Practically all manufacturing plants hitherto run by steam are now operated by electric power produced in large central power stations that use gas or fuel oil. These changes have resulted in decreasing the value of all coal lands to such an extent that some tracts upon which \$10,000 to \$15,000 had been paid have reverted to the Indian nations. The last public auction, held in 1925, resulted in the sale of only four tracts out of the several hundred offered.

Three nonproducing volcanic-ash leases covering 236.97 acres and one nonproducing zinc-lead lease were inspected during the year. Cooperation with the Oklahoma Geological Survey in tracing and mapping the coal outcrop in Muskogee and McIntosh Counties was continued.

Leases and tracts under supervision on segregated and restricted allotted Indian coal lands

	Produc- ing	Nonproduc- ing	Acres
Segregated leases and tracts:			
Coal leases not sold.....	37	21	54, 090. 11
Coal leases sold.....	6	1	5, 150. 00
Asphalt leases.....		1	900. 00
Purchased unleased tracts.....	4	11	12, 124. 34
Remaining unleased tracts.....		373	318, 196. 06
Allotted leases:			
Cherokee.....	3	5	579. 00
Choctaw.....	6	8	871. 31
Creek.....	7	30	3, 468. 92
Miscellaneous mineral leases:			
Volcanic ash—			
Creek.....		2	120. 00
Choctaw.....		1	116. 97
Lead and zinc—Cherokee.....		1	99. 88
	63	453	396, 386. 26

Status of oil and gas lands belonging to Five Utilized Tribes

	Leases			Wells	
	Nonproduc- ing	Produc- ing	Total	Produc- ing	Drilling
Cherokee.....		376			
Choctaw.....		64			
Creek.....	6, 456	603	7, 061	5, 200	38
Chickasaw.....		20			
Seminole.....		162			
	6, 456	1, 225	7, 681	5, 200	38

During the year 61 investigations were made relative to gas waste, improper methods of production, surface conditions on areas covered by expired departmental permits, and correlative appraisal of Indian allotments located near producing wells. A few of the engineering features resulting in augmenting the royalties to the Indians on allotted lands are cited below:

Creek Agency: A gas sand penetrated in the course of drilling for oil and adequately protected by mudding ultimately netted the lessor a bonus of \$3,150 paid for the gas rights on expiration of the oil lease. A recommendation to deepen a gas well resulted in an increase in the gas produced from 3,000,000 to 33,000,000 cubic feet a day.

Seminole Agency: Study of subsurface conditions resulted in changing the method of setting well casings and the producing operations of the wells, which gave a lower oil gas ratio, with a consequent daily saving of 54,000,000 cubic feet of gas, having an estimated value of \$4,300. Notice was given to the operator of a single well to suspend production until an arrangement was made for economic utilization of the gas; under an approved plan for curtailment and a sales arrangement covering reduced volume of gas the daily revenue from the well increased from \$200 to \$400. Recommended deepening and shooting a well increased the daily oil production from 47 to 247 barrels, a gain which should net the allottee \$4,000 for the year.

Quapaw Indian Reservation: The mining engineers of the Miami office maintain supervision over operations on the restricted Quapaw Indian lands in northeastern Oklahoma. During the fiscal year 1930 an average of 33 mine ore and tailing mills were in operation on these lands. These mills, which represented 40 per cent of the average number of mills in operation in the Tri-State district during the year, produced 23 per cent of the zinc concentrates and 33 per cent of the lead concentrates of the district, or 14.2 per cent of the zinc and 3.9 per cent of the lead mined in the United States. At the end of the year there were in force under departmental supervision 50 lead and zinc mining leases, embracing 6,244 acres, and 43 subleases, embracing 2,214 acres. From these leases, 144,805 tons of lead and zinc concentrates

were sold during the year for \$6,166,601.93. The royalty paid to the Indians amounted to \$587,255.08, and in addition they received \$1,477.30 collected as advance rental, paid in lieu of royalty on nonproducing leases, and \$1,368.60 from the sale of mill tailings.

Marked progress was made toward the consolidation of lease units for centralized milling, and the resulting economies of operation, higher recovery, and lower grade of ore thereby made available will add materially to the ultimate income of the Indian owners of the land. Seventeen separate consolidations of two to five producing units each have been consummated, and permits for centralized milling have been granted by the Secretary of the Interior.

Tests made by the Miami office indicate that the loss in tailing piles through leaching and oxidation of recoverable lead and zinc approximates 10 per cent a year. Continued efforts to secure the early re-treatment of tailings have met with success, and practically all the re-treatable tailing piles on restricted allotments have been or are now being remilled. At the end of the year 10 of the 14 tailing mills in operation in the Tri State district were located upon restricted lands.

Examinations and reports were made relative to lead and zinc mining operations on lands of a Cherokee allottee near Fairland County, a bonus for leasing Cherokee lands near Welsh, and an application for a lead and zinc mining lease on allotted Wyandot Indian lands.

A 1,000-foot geologic section was completed across the Quapaw Reservation to show the principal structural features and the relationship between these features and the ore bodies. This is the first detailed work of this character in this district and is of great assistance to the departmental lessees in their drilling for deeper runs of ore.

An estimate of the tonnage of ore reserves was completed to show the value and expected royalty income from the remaining ore bodies on restricted Quapaw Indian allotments. This information has been summarized for use by the Quapaw Agency in the future disbursement of Indian funds.

There were 15 fatal accidents in the lead and zinc mines of the Tri-State district during the fiscal year, but only 5 of these occurred at mines on restricted Indian lands—one fatality to each 700,000 tons of ore mined.

Zinc and lead produced on Quapaw Indian lands, 1924-1930

Fiscal year	Concentrates (tons)		Total value	Royalty	Other payments
	Zinc sulphide	Lead sulphide			
1924.....	175,989	45,553	\$10,961,885	\$901,405.70	-----
1925.....	210,306	49,126	15,135,569	1,351,720.63	-----
1926.....	236,971	52,651	17,672,498	1,679,863.75	\$106,066.65
1927.....	210,622	45,890	14,131,113	1,307,114.54	3,208.63
1928.....	181,139	34,830	9,424,720	894,820.30	2,889.30
1929.....	150,670	35,752	8,809,442	848,219.49	5,708.31
1930.....	121,333	23,472	6,166,602	587,255.08	2,840.90

Pawnee and other agencies: The status of oil and gas lands under the Pawnee Agency is as follows:

Status of oil and gas lands under Pawnee Agency

	Leases			Producing wells
	Nonproducing	Producing	Total	
Ponca.....	154	14	168	54
Otoe.....	222	2	224	2
Tonkawa.....	24		24	
Pawnee.....	195	19	214	66
Kaw.....	48	4	52	33
	643	39	682	155

During the year the four Indian agencies in this district have held 17 oil and gas sales, and technical advice was furnished on the adequacy of the bids received.

Appraised value of tracts involved in oil and gas sales, Pawnee and other agencies

	Sales	Allotments appraised	Acres appraised	Bonus	
				Total	Average per acre
Pawnee.....	7	173	13, 046. 56	\$116, 914. 11	\$8. 56
Shawnee.....	2	43	3, 370. 04	41, 811. 59	12. 41
Kiowa.....	5	601	74, 021. 41	172, 854. 67	2. 34
Cheyenne and Arapaho.....	3	169	16, 759. 88	77, 825. 08	4. 64
	17	986	107, 198. 89	409, 405. 45	3. 82

Kiowa Agency: The status of oil and gas lands under the Kiowa Agency is shown below:

Status of oil and gas lands under Kiowa Agency

	Leases			Wells	
	Nonproducing	Producing	Total	Producing	Drilling
Kiowa.....	170	-----	170	-----	-----
Comanche.....	324	17	341	30	3
Apache.....	22	5	27	17	-----
Wichita.....	142	-----	142	-----	-----
Caddo.....	206	-----	206	-----	-----
	863	22	885	47	3

Appraised 986 allotments embracing 107,148 acres, offered for sale at an estimated bonus value of \$409,405, of which 731 tracts, involving 81,593 acres, sold for \$268,271. By recommendation of the district engineer that sealed bids be invited instead of conducting auction sales, an increased return of \$67,481 was realized by the allottees.

UTAH

Uintah-Uray Reservation: 1 coal lease. On the Navajo Executive order lands in southeastern Utah 4 wells have been abandoned.

WYOMING

With the exception of one deep test hole at Pilot Butte practically no new development work has been done on the Shoshone Indian Reservation during the year. The Lander and Pilot Butte fields have been productive, although owing to the decreased market demand for black oil, the Lander field has not produced to capacity.

The special investigations and reports made to the benefit of the Indians numbered 62. The value of some of the work can not be determined on the basis of immediate results or estimated in money value pending settlement. Typical investigations are described briefly below:

Ponca Agency: Damage to eight allotments by refinery waste oil was appraised at \$10,650 to January 1, 1930. A gas repressuring project in the South Ponca field had been conducted efficiently prior to the merger of the leading operating company. After the merger a change in the operating method involved the removal of all input gas meters; notice was given to discontinue that practice of uncontrolled repressuring and to replace all meters. Replacement of meters is in progress, and the work will be inspected when completed.

Status of oil and gas lands under Shawnee Agency

	Leases			Produc- ing wells
	Nonpro- ducing	Produc- ing	Total	
Iowa.....	22		22	
Kickapoo.....	90		90	
Pottawatomie.....	65	9	74	31
Sac and Fox.....	165	8	173	23
Shawnee.....	210		210	
	552	17	569	54

Sac and Fox Agency: Payment of \$2,703 was made as a royalty settlement in lieu of drilling required offset wells.

Wells on Indian oil and gas lands in Wyoming

Land	Drilling		Producing		Aban- doned	Plugged and aban- doned	Total
	Active	Sus- pended	Active	Shut in			
Tribal.....		1	• 11	36	22	37	107
Allotted:							
Trust patented.....			• 24		30	6	60
Patented.....	1	2	• 11	3	22	11	50
	1	3	46	39	74	54	217

• 1 water well.

• 9 oil, 2 gas (not commercial).

COOPERATIVE WORK

Cooperative work was conducted with the Bureau of Mines and the Bureau of Standards in connection with tests of mine stoppings to withstand explosions of gas and coal dust; with the Bureau of Mines in its rock-dusting, ventilation, and experimental mine programs and oil and gas technologic investigations; with the Bureau of Reclamation in conjunction with its lease on the power and coal mine at Williston, N. Dak.; with the National Research Council on the conservation of the scientific results of drilling and the improvement of drilling methods and equipment; with the Industrial Commission of Utah on explosions in the Standardville and New Peerless mines and the increase in the use of rock dust in Utah coal mines as a preventive against the propagation of local explosions throughout the mines; with the Oklahoma Geological Survey in the study of the zinc and lead ore deposits in northeastern Oklahoma and the preparation for publication of maps showing coal outcrops and related geologic data in the Muskogee-Whitefield area; with the Bureau of Mines and the General Land Office in examining and studying means for extinguishing fires on coal outcrops on the public domain, some of which have been burning for several decades and one, at Coalmont, Colo., has consumed the coal in an area of about 6 acres and threatens destruction of over 4,000,000 tons of coal. Cooperation with the technical committee on the scientific classification of coals of the American Society for Testing Materials was also continued.

WORK ON PUBLICATIONS

TEXTS

BERNARD H. LANE, *Editor*

During the year 20,885 pages of manuscript were edited and prepared for printing by the section of texts, and 3,494 galley proofs and 16,932 page proofs were read and corrected. Indexes were prepared for 40 publications, covering 9,248 pages. Copy and proof or stencils for 1,901 pages of multigraph and mimeograph matter were read. At the end of the year four persons were employed in this section. The publications issued during the year are listed on pages 4-8.

The editor is serving as a member of the departmental subcommittee to assist in the revision of the Style Manual of the Government Printing Office. The other members of this subcommittee represent the Bureau of Standards, the Smithsonian Institution, the State Department, the Department of Agriculture, and the Library of Congress.

ILLUSTRATIONS

C. A. WECKERLY, *Chief Illustrator*

The number of drawings and photographs prepared by the section of illustrations was 3,158, including 132 maps, 364 sections and diagrams, 45 charts and plans, 547 photographs, and 2,070 paleontologic drawings; 128 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany 32 reports numbered 754, to be reproduced by chromolithography, photolithography, half-tone, and zinc etching. The number of proofs received and examined was 980. At the end of the year material for illustrating 25 reports was in hand. The section consists of eight employees.

GEOLOGIC EDITING AND DRAFTING OF MAPS AND ILLUSTRATIONS

GEORGE W. STOSE, *Editor of Geologic Maps*

The Fairfield-Gettysburg (Pa.) folio was completed during the year and published as Folio 225. The maps and sections of the Gaffney-Kings Mountain (S. C., N. C.) folio were being prepared on stone for color proof. The maps and structure sections of the Coatesville-West Chester (Pa.) folio made no progress during the year, awaiting transfer to stone. The maps of the Somerset-Windber (Pa.) folio were engraved and made ready for transfer to stone, but no progress was made on the engraving of the structure sections. The maps of the Montevallo-Columbiana (Ala.) folio were in plate proof. No progress was made on the engraving of the maps and structure sections of the Boston folio. The maps of the Hollidaysburg-Huntingdon (Pa.) folio were engraved.

The geologic map of Arkansas was completed and published for the Arkansas Geological Survey, and two topographic maps of the State showing mineral industries and power-transmission lines were in color proof. The geologic map of Kentucky was completed and published for the Kentucky Geological Survey. A block diagram of the Tonopah mining district, Nevada, was drawn and photo-

lithographed and reached color proof. The geologic map of Pennsylvania, compiled in cooperation with the Pennsylvania Geological Survey, was completed and submitted for publication. Compilation of the geologic map of California, in cooperation with the California Division of Mines, and of the geologic map of Texas was begun. The compilation of the geologic map of the United States on the scale of 1:2,500,000 was well advanced.

Illustrations for 25 reports were examined and edited, and geologic advice was given to members of the section of illustrations. Work was done on the maps of the San Juan region of southwestern Colorado for the authors, and oil and gas maps of Texas and Louisiana were compiled and drawn. Illustrations for 23 other reports by geologists were drawn.

INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

W. M. BEAMAN, Chief

During the year 156 new topographic maps were edited and transmitted for engraving, 270 published topographic maps, 15 State maps, and 10 State index circulars were edited for reprint, and 289 maps were edited as illustrations for Geological Survey reports—a total of 740 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 462 and proofs of maps reproduced by photolithography in one to three colors numbering 187 were read. At the end of the year 182 new topographic maps were in progress of engraving and printing and 205 new topographic maps were in preparation for submission for reproduction.

DISTRIBUTION

R. C. SHELSE, Chief

A total of 313 publications, comprising 77 new books and pamphlets, 91 new or revised topographic and other maps, and 145 reprinted topographic and other maps, were received by the division distribution during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 179,089 books and pamphlets, 5,030 geologic folios, and 660,767 topographic and other maps, a grand total of 845,123.

The division distributed 161,214 books and pamphlets, 5,040 geologic folios, and 828,303 maps, a grand total of 833,343, of which 4,197 folios and 691,610 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$46,480.18, including \$44,779.98 for topographic and geologic maps and \$1,700.20 for geologic folios. In addition to this \$2,159.38 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$48,639.56.

The division received and answered 68,858 letters.

ENGRAVING AND PRINTING

S. J. KUBEL, *Chief Engraver*

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the fiscal year 78 new topographic maps were engraved and printed, including one revised map, and 13 new maps were photolithographed and printed, making a total of 91 new maps printed and delivered. One fractional map was engraved but not printed. Corrections were engraved on the plates of 216 maps. Reprint editions of 132 engraved topographic maps and 13 photolithographed State and other maps were printed and delivered. In addition, 61 new topographic maps had been engraved and were in press June 30, and the engraving of 24 other new topographic maps, also the United States map on a scale of 1:2,500,000, was nearly completed. Of new and reprinted maps 658,450 copies were delivered. One new geologic folio was printed, its edition amounting to 5,030 copies. Two extra geologic sheets of folios numbering 2,317 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, the office of the Secretary of the Interior, the Bureau of Reclamation, Office of Education, General Land Office, National Park Service, Indian Service, Alaska Railroad, Bureau of Pensions, Bureau of Public Roads, Bureau of Agricultural Economics, Bureau of Plant Industry, Forest Service, Bureau of Biological Survey, Weather Bureau, Plant Quarantine and Control Administration, Bureau of Standards, Bureau of Lighthouses, Bureau of Foreign and Domestic Commerce, Bureau of Mines, Bureau of Fisheries, Federal Radio Commission, Coast and Geodetic Survey, Department of Labor, Department of State, War Department, Post Office Department, Treasury Department, Department of Agriculture, Department of Commerce, Interstate Commerce Commission, Federal Power Commission, National Capital Park and Planning Commission, Commission of Fine Arts, International Boundary Commission, Children's Bureau, Bureau of Customs, Washington Navy Yard, United States Military Academy, Office of the Chief of Engineers, Coast Artillery School, General Service Schools, Army War College, United States Marine Corps, United States Naval Academy, Federal Board for Vocational Education, United States Veterans' Bureau, Regional Plan of New York and its Environs, and the States of Kansas, Connecticut, Arkansas, Kentucky, California, and Texas. This work done for other branches of the Government and State governments included many reprints, and the charges for it amounted to about \$146,000, for which the appropriation for engraving and printing geologic and topographic maps was reimbursed.

Transfer impressions numbering 469 were made during the year, including 282 furnished to contracting lithographic printers on requisition of the Government Printing Office, 4 furnished to other branches of the Government, 124 furnished to State surveys, and 59 furnished to private firms. The amount turned over to miscellaneous receipts was \$553.

Of contract and miscellaneous work of all kinds, 2,525,790 copies were printed. Including topographic maps and geologic folios, a grand total of 3,191,587 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 10,649 negatives (4,942 wet (of which 3,994 were for photolithographs), 29 paper, 2,108 dry, and 2,875 field negatives), 695 lantern slides, 28,227 prints (3,816 maps and diagrams and 24,411 photographs for illustrations), 3,467 zinc plates, 266 zinc etchings, 21 celluloid prints, 100 lantern slides colored, 10 transparencies colored, 24 prints colored, and 2,252 prints mounted.

ADMINISTRATION

JULIAN D. SEARS, Administrative Geologist

JOHN J. MADIGAN, Chief Clerk

The administrative geologist assists the director in all phases of general administration, performs special tasks assigned to him by the director from time to time, serves as acting director in the director's absence, and has special supervision over the section of illustrations.

The chief clerk, in addition to performing the duties usually pertaining to that office, serves as budget officer and exercises administrative supervision over the division of engraving and printing, the division of distribution, the section of correspondence and records, the section of accounts, the library, and the division of field equipment.

CORRESPONDENCE AND RECORDS

C. A. KING, Chief

Mails, files, and records.—During the year 99,488 pieces of mail, of which 2,017 were registered, were opened and referred. In addition 116,755 letters were received direct by the other divisions, making a total of 216,243, a decrease of 17 per cent compared with 1929. Of the letters opened in this section 19,136 contained \$46,815.22 remitted for Geological Survey publications. The number of ordinary letters mailed through the section was 60,589; of registered letters and packages, 964. In addition, 126,966 pieces of mail were sent out direct from other divisions. The total number of outgoing pieces of mail for the Geological Survey was 188,519.

Freight and express.—During the year 2,665 pieces of freight and express were handled, 1,409 outgoing and 1,256 incoming.

Personnel.—The roll of Secretary's appointees numbered 1,065 at the end of the fiscal year, 68 more than at the end of 1929. The total number of changes in personnel was 1,092, including 215 appointments, 147 separations, and 730 miscellaneous changes.

During the calendar year 1929 17,868 days of annual leave and 3,602 days of sick leave were granted, being 68 per cent of the amount of annual leave that could have been taken and 13 per cent of the sick leave that it would have been possible to grant. In addition 8,475 days of leave without pay and furloughs were also granted.

*ACCOUNTS**C. K. FRANCIS, Chief*

During the year 18,747 field accounts, 1,687 transportation bills, and 261 telegraph bills were audited and transmitted for payment. In the audit of these accounts 944 suspensions and disallowances were made. The section received 158 printing and binding requisitions, 913 stationery requisitions, 2,424 miscellaneous supply requisitions, 1,462 letters of employment, and 375 contracts.

Condensed statements covering expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

Amounts appropriated for, transferred to, and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1930.

	Funds available			Expenditures			Balance
	Amount of appropriation	Repayments on account of work performed		Total	Disbursements	Outstanding liabilities	
		Made	To be made				
APPROPRIATIONS							
Salaries.....	\$134,800.00	\$274,770.88	\$74,842.43	\$134,800.00	\$134,769.66		\$30.34
Topographic surveys.....	635,000.00	33,924.78	15.00	964,622.31	965,727.50	\$16,894.77	2,000.34
Shenandoah National Park in Virginia.....	33,000.00	35,924.78	1,611.24	35,551.02	34,653.61	8,907.61	
Geologic surveys.....	350,000.00	26,024.79	9,080.12	385,104.91	375,980.96	8,190.61	1,333.34
Volcanologic surveys.....	21,000.00			21,000.00	19,840.28	1,110.14	49.58
African mineral resources.....	61,500.00	1,794.86	153.87	69,411.73	55,914.31	13,267.33	230.09
Glacial streams.....	275,000.00	344,742.48	55,843.25	675,592.73	665,855.28	7,984.19	1,722.25
Classification of lands.....	180,000.00	268.25		180,268.25	177,978.97	2,160.93	123.35
Geologic and topographic maps of the United States.....	107,000.00	120,568.08	23,864.77	251,433.85	235,000.43	12,640.13	863.25
Preparation of illustrations.....	20,000.00	964.19		21,164.19	21,163.09		1.10
Mineral leasing.....	250,000.00	834.13		250,834.13	245,525.43	3,548.08	1,760.67
Plugging wells.....	50,000.00			50,000.00	6,809.25	6,809.25	43,190.75
Great Smoky Mountains National Park in North Carolina and Tennessee.....	57,945.34	233.33		58,178.16	50,122.15	1,036.91	7,020.10
	2,182,670.63	769,880.98	165,308.68	3,117,960.28	2,991,429.62	68,170.56	\$ 15,360.21
TRANSFERS							
Engineering, Bureau of Engineering (Navy Department, act Mar. 4, 1929) 1930.....	50,000.00	127.10		50,127.10	50,080.14		37.95
Federal Power Commission (act Mar. 4, 1929) 1930.....	5,250.00	16.41		5,266.41	4,024.64	968.00	273.57
Flood control, Mississippi River and tributaries (War Department, act Mar. 4, 1929).....	121,007.00	1,008.57		122,015.57	110,998.47	4,868.87	6,468.28
Flood control, Mississippi River and tributaries (War Department, act Mar. 7, 1928).....	1,859.35	.69	37.47	1,906.91	1,450.14	536.77	
Investigating potash deposits, Bureau of Mines (Commerce Department, act Jan. 25, 1929) 1930.....	12,800.00		83.33	12,883.33	12,172.64	377.44	33.25
Maintenance and improvement of existing river and harbor works (War Department, act Mar. 4, 1929).....	316,656.00	1,832.39	99.09	318,607.48	267,303.00	14,232.22	37,071.66
Maintenance and improvement of existing river and harbor works (War Department, act Mar. 7, 1928).....	17,284.88	105.85		17,390.73	7,907.76	1,819.10	7,663.87

* In addition to these appropriations an item of \$150,000 for printing and binding for the Geological Survey was contained in the appropriation act, but the account was not kept in the Geological Survey. There was also an allotment of \$12,960 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

† Of this balance, \$43,190.75 for plugging wells and \$7,020.10 for Great Smoky Mountains National Park is available for expenditure during the fiscal year 1931, leaving a net balance or the fiscal year 1930 of \$8,149.

Amounts appropriated for, transferred to, and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1930—Continued

	Funds available				Expenditures			Balance
	Amount of appropriation	Repayments on account of work performed		Total	Disbursements	Outstanding liabilities	Total	
		Made	To be made					
TRANSFERS—continued								
Maps of the United States (act May 21, 1920), 1930.....	\$11,375.00		\$235.00	\$11,610.00	\$6,851.08	\$2,758.32	\$11,610.00	-----
Supervising mining operations on leased Indian lands (act Mar. 4, 1929), 1930.....	75,000.00	\$1,802.51		76,802.51	76,228.21	565.02	76,793.23	\$9.28
Supervising mining operations on leased Indian lands (act Mar. 26, 1930), 1930.....	10,000.00		528.33	10,528.33	10,218.44	120.94	10,339.38	188.95
Water boundary, United States and Mexico (State Department, act Jan. 25, 1929), 1930.....	18,440.00	103.49		18,543.49	18,489.11	54.34	18,543.45	.04
Waterways treaty, United States and Great Britain (State Department, act Jan. 25, 1929), 1930.....	75,000.00	531.57	136.50	75,671.07	73,964.59	1,265.40	75,229.99	441.08
Waterways treaty, United States and Great Britain (State Department, act Mar. 4, 1929), 1930.....	15,000.00	3,299.81		18,299.81	17,898.94	210.42	18,109.36	190.45
Ammunition storage facilities, Navy (Navy Department, act Mar. 4, 1929).....	1,400.00			1,400.00		997.48	997.48	402.52
Maintenance, Bureau of Yards and Docks (Navy Department, act Mar. 4, 1929), 1930.....	1,500.00	147.36		1,647.36	1,647.36		1,647.36	-----
	2,915,042.85	778,887.13	106,508.40	3,860,438.38	3,652,372.44	96,834.87	3,749,307.31	111,131.07

ADMINISTRATION

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Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1930

Object of expenditure	Geological Survey salaries	Topographic surveys	Geologic surveys	Volcano-logic surveys	Alaskan mineral resources	Gaging streams	Classification of lands	Geologic and topographic maps of the United States	Preparation of illustrations	Mineral leasing	Total
Personal services.....	\$134,769.66	\$817,600.24	\$332,038.11	\$17,508.13	\$51,538.21	\$672,643.99	\$152,268.57	\$201,750.75	\$20,563.08	\$296,865.65	\$2,697,468.39
Stationery and office supplies.....		5,889.08	704.13	158.44	3,489.13	6,762.12	287.11	28,322.02	161.12	1,974.67	46,697.82
Scientific and educational supplies.....		1,187.90	1,086.96	24.24		106.62	10.58		1.42	1,591.51	1,591.51
Sundry supplies.....		3,268.98	1,026.76	372.77	125.77	3,485.12	188.98	6,238.02	126.30	173.79	15,303.18
Subsistence and care of animals and storage and care of vehicles.....		2,410.39	866.29			89.50	237.29			59.76	3,663.23
Telephone service.....		642.86	244.52	25	73.97	922.93	57.16	3.62		773.22	2,908.53
Telegraph service.....		252.25	105.90	53.55	26.40	1,351.99	75.30			2,492.86	4,357.25
Other communication service.....		20.67		90		18.81				83.00	123.38
Travel expenses.....		128,980.41	23,947.28	927.15	8,955.13	85,910.90	14,258.71	85.59	2.37	23,945.23	287,015.77
Attendance at meetings.....		119.03	1,007.42			967.45				1,020.23	3,114.13
Hire, maintenance, operation, repair of horse-drawn and motor-propelled passenger-carrying vehicles.....		1,435.76	2,005.98	251.29		26,504.77	6,122.15			21,542.95	57,862.90
Transportation of things.....		54,840.88	6,305.39	418.03	3,518.33	26,286.40	1,870.10	136.91		2,720.98	96,596.97
Lithographing, engraving, and etching.....		18,161.24	820.82			860.15	1,179.79		70.22	171.59	21,263.81
Stenographic work, typewriting, and duplicating work, etc. (job work).....		50	17.50			14.80	8.50			.50	41.80
Photographing and making photographs and prints.....		36,283.49	4,556.24	63.85	883.08	2,640.49	1,434.66	7,877.51	206.44	316.63	53,762.39
Heat, light, power, water, and electricity.....			66.31	50.00	45.16	60.53				4,568.35	4,785.35
Rents.....		273.07				2,951.00				11,546.41	11,546.41
Repairs and alterations.....		356.47	131.58	120.42	15.42	1,994.70	40.26	1,928.08		8,434.29	13,021.26
Special and miscellaneous current expenses.....			266.46		7.25	758.85	75			743.19	2,583.68
Purchase of passenger-carrying vehicles.....		1,106.55	945.40		42.25	7,512.00	2,568.80			13,296.76	25,419.51
Furniture, furnishings, and fixtures.....		1,922.54	766.91	413.56	42.25	6,118.90	201.15	270.30		753.23	9,491.84
Educational and scientific equipment.....		27,714.69	10,421.29	347.10	780.40	40,640.51	1,485.96	2,114.00		2,064.64	85,568.59
Other equipment.....		31,772.09	6,555.48	78.52	212.14	18,245.03	1,457.29	12,809.20		376.16	71,507.91
Structures.....		8,791.77		58.75		42,929.07					51,769.59
Miscellaneous transfers and adjustments		43,920.74	2,441.92	103.47		132,935.81	741.46	704.61	82.14	1,963.96	182,644.11
	134,769.66	1,186,468.73	396,321.65	20,950.42	69,131.64	1,080,622.53	184,484.57	262,240.56	21,163.09	363,104.46	3,749,307.31

LIBRARY

GUY E. MITCHELL, *Librarian*

The library of the Geological Survey, which forms the greater part of the Interior Department scientific library, is a public library, as provided by law. It serves the members of the Geological Survey, but its service to others is numerically greater—51 per cent according to records kept since January, 1930. This outside public service is but one expression of the general Geological Survey policy to make freely available the information it has collected.

The manuscript of the bibliography of North American geology for 1919–1928 was completed and transmitted during the year, for publication as Bulletin 823. This is a 10-year cumulation that supplements the bibliography for 1785–1918 published as Bulletins 746 and 747 and will form one of the most valuable working tools for geologists. The preparation of the bibliography for 1929 and 1930 is in progress.

The "List of serial publications of foreign countries" has been furnished to this library for checking. This is a project sponsored by the American Library Association, the American Council of Learned Societies, and the National Research Council, and one in which all the important libraries in the United States are cooperating. The purpose is to show where any particular serial publication may be found in the libraries throughout the United States and Canada. During the year the Geological Survey library has found and reported 481 titles of serials published in Mexico, Central and South America, the British Empire overseas, Italy, Spain, Portugal, Switzerland, Belgium, the Netherlands, and the Scandinavian and Baltic countries.

Binding, one of the prime requisites of a library, has been in continual arrears in this library for many years. Several thousand of the older books are badly in need of rebinding, and other thousands of valuable paper-covered foreign publications should be bound. The volumes prepared for regular binding during the year represented an increase of nearly 35 per cent over the average for the last five years. In addition about 500 paper-covered books have been encased in substantial stiff binders with linen backs, made by the engraving division in spare time at an average cost of about 14 cents each. This may be compared with the cheapest binder on the Government schedule, which costs 37 cents each but is not as good.

Leather labeling of books has been discontinued, as the best leather available has an average life of only about 25 years, which is presumably not more than half of the life of good buckram. Titles are now printed in gold direct on buckram.

Bound copies of many Government publications (heretofore bound by the library) have been obtained through arrangement with the publishing offices at an estimated saving thus far of over \$400 in binding cost. The arrangement is a continuing and reciprocal one, the Geological Survey having agreed to supply several offices with bound copies of its own publications instead of paper-covered copies.

Some 5,500 books and periodicals have been disposed of, to the Library of Congress and elsewhere, permitting a reorganization of shelving space on all three floors that has given much-needed relief

from shelf crowding. Several out of town university geologic libraries have been supplied with more than 600 surplus publications—books of which this library had duplicate or triplicate copies. The cost of the extra work involved in boxing and shipping these books (outside of office hours) has been borne by these institutions.

The year's accessions comprised 13,340 books, pamphlets, and periodicals and 1,073 maps. The recorded loans were 5,573 books and 171 maps, in addition to those used by 6,743 readers who consulted the library in person. The card catalogue was increased by the addition of 11,314 cards. Title entries to the number of 536 were furnished to the Library of Congress for printing; the proof reading of these titles involved 126 galleys. Correspondence handled included 1,635 letters received and 1,521 letters sent. Communications in foreign languages to the number of 76 were translated for other divisions of the Geological Survey. The volumes prepared for binding numbered 1,296, and 421 newly bound volumes were labeled, plated, and shelved. Numerous loans were made to libraries in Washington and in other places, and a considerable volume of reference work was done in the usual course of the library's service to specialists and students, both in and out of the Geological Survey.

FIELD EQUIPMENT

R. L. ATKINSON, Chief

The instrument shop designed a theodolite, a leveling rod, a precise level, a reel for 300-foot chain tapes, a range pole, and a tripod leg; designed and constructed precise-leveling rods, an airplane-camera mount, temperature apparatus, pressure bombs, a nonmagnetic stainless-steel reticule, a columnation testing apparatus, turning pins, and leveling-cup pins; rebuilt and repaired 2,707 instruments of different kinds; constructed special apparatus and made repairs for the chemical laboratory, petrographic laboratory, and engraving division; tested all New York and precise rods and 300-foot band chains; and did work for the Corps of Engineers, district engineers, National Park Service, Indian Service, Bureau of Reclamation, Forest Service, and Bureau of Mines.

The cabinet shop designed and constructed explorer's alidade carrying cases, a standard copperplate storage case, a case for assorted-size plates, a proof-sheet filing case, a set of three cases for an airplane camera, combination stadia and level rods, shadowgraphs, a case for microcamera set, an enlarging camera, and a projection slide; made and fitted stadia and invar rods and cases; and did repair and upkeep work on cases, rods, tripods, and plane-table boards.

The electrical shop designed and constructed a special rheostat for temperature control; redesigned transformers used in aerial photography, motor drive on plate-grinding machine, mount and feed on diamond-saw motor, and motor control on electrically driven camera; installed a 10-horsepower motor and control system; and inspected and repaired electric motors, heaters, and temperature apparatus.

The express, freight, and mail packages shipped and received by the division amounted to nearly 86 tons.

Overtime amounting to 1,100½ hours was reported by 14 employees.

GEORGE OTIS SMITH, Director.

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UNITED STATES DEPARTMENT OF THE INTERIOR

*ANNUAL REPORT OF THE
DIRECTOR OF
THE GEOLOGICAL SURVEY
TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1931*



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UNITED STATES DEPARTMENT OF THE INTERIOR

FIFTY-SECOND ANNUAL REPORT

OF THE

*DIRECTOR OF
THE GEOLOGICAL SURVEY*

TO THE

SECRETARY OF THE INTERIOR

1931



*UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1931*



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Directors of the Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907

GEORGE OTIS SMITH, 1907-1930

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ANNUAL REPORT

OF THE

DIRECTOR OF THE GEOLOGICAL SURVEY

W. C. MENDENHALL, *Acting Director*

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 15, 1931.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1931 included 17 items, amounting to \$2,869,990.85. In addition there was allotted \$13,013.75 for miscellaneous supplies from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of the report. The balance on July 31 was \$171,300.31.

The total amount of funds made available for disbursement by the Geological Survey, together with State funds directly disbursed for work administered by the Federal officials, was \$4,842,151.02.

ORGANIZATION AND PROGRESS

The pages that follow set forth briefly the organization and the varied activities of the United States Geological Survey in the fifty-second year of its existence. Established in 1879, it was given by Congress a broad mandate for "the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain." Specific provision was made for the publication of the results obtained in the execution of this mandate. Building upon this legislative foundation, the Geological Survey for more than half a century has endeavored to maintain high standards of professional work and conduct, to make steady contributions to the advance of knowledge within its assigned fields, and to apply this knowledge in the mineral industry, in cartography, and in hydrography. More than 2,000 volumes and many thousands of maps dealing with geology, mineral resources, water supplies, and other topics germane to the activities of the Geological Survey have been published.

The geologic branch is the senior of the Geological Survey's major units, the one from whose initial activities most of the other branches and several separate bureaus and institutions have sprung. Chief among these separate organizations are the Bureau of Ameri-

can Ethnology, the Bureau of Mines, and the Geophysical Laboratory of the Carnegie Institution.

The energies of the branch have necessarily been divided from the beginning between fundamental geology and applied geology. It has always recognized that sound work on the principles of any science must precede an attempt to apply the principles in everyday affairs. This essential idea has had gratifying recognition during the past year in the granting of a specific appropriation for geologic research. A summary of the branch's activities during the fiscal year 1931 appears elsewhere in this report.

Improving upon the beginnings made by its predecessors—the great exploratory surveys of the sixties and seventies of the nineteenth century—the Geological Survey early developed and applied in this country the art of topographic mapping, in order to have for its own use those base maps that are so essential to accurate studies of geology and mineral resources. These maps have proved so valuable in many engineering and other fields that the demands for them outside the Geological Survey have obscured and far outrun their original purpose. The topographic branch, devoted to the making of these maps, is now one of the most important units of the organization. Its activities for the fiscal year 1931 are briefly set forth in succeeding pages.

As settlement has extended across the continent in the last half century and invaded the arid and semiarid regions, and as cities in the East have grown and industrial development has become more intensive, the vital nature of the problem of adequate water supplies has penetrated the consciousness of our citizens.

In anticipation of this development and parallel with it, the Geological Survey has endeavored from an early date in its history to collect and to make public definite records of available water supplies. The value of these records increases with their length and their degree of completeness, and the uses to which they are put in planning irrigation enterprises and in municipal and industrial development are constantly multiplying. The water-resources branch is the unit upon which this work devolves. Out of the earlier activities of this branch grew the Bureau of Reclamation, at first a part of the Geological Survey, now a separate service in the Department of the Interior.

With the stimulus given to mining in Alaska by the discovery of the Klondike near the end of the last century, the activities of the Geological Survey in that Territory, previously desultory, were increased and systematized and eventually were recognized by the establishment of an Alaskan branch, which for more than a quarter of a century has been actively identified with the development of the Territory. Over 46 per cent of the area has now been mapped topographically and nearly 44 per cent geologically, the maps and the reports that accompany them serving as valuable guides in all mining and prospecting activities.

The latest of the Geological Survey's great field branches to be established is the conservation branch. Its function of land classification, first separated as the duty of an independent unit in 1912, had grown, like most of the other Geological Survey activities, out of the geologic branch, which began early in this century the classifi-

cation of lands into some of the categories recognized in the public land laws. This activity represents a delayed recognition of one of the functions delegated to the Geological Survey at the time of its establishment—a function impossible to exercise in the early years of small appropriations and small staffs. With the more definite statutory recognition, especially during the last 20 years, of different classes of public lands and the necessity of separating the lands into these classes in order that the statutes might be applied; with the enactment of mineral leasing laws; and, finally, with the transfer from the Bureau of Mines to the Geological Survey in 1925 of the technical administration of these laws under the department, this branch has grown in functions and importance into one of the major units of the organization.

With the encouragement of cordial and increased interest and support by the administration and the Congress, moderate expansion has been possible in the staff and in a number of the activities of the Geological Survey during the fifty-second year of its existence. Especially noteworthy has been the growth in geologic investigations and studies of water resources. Geologic work was strengthened by an increase in the appropriation "for geologic surveys" and by the granting of a new fund "for fundamental research in geologic science" which permitted the beginning of studies in some of the many problems that have long awaited attention. Broadened investigations of the surface and underground waters of the country were made possible by increased funds appropriated as a recognition by Congress of the national interest in this vital natural resource.

RESIGNATION OF THE DIRECTOR

December 22, 1930, George Otis Smith resigned as Director of the Geological Survey to accept the appointment as chairman of the reorganized Federal Power Commission.

A member of the Geological Survey since 1896, Doctor Smith became its fourth director on May 1, 1907, and served in that capacity continuously until 1930, except for about 10 months in 1922 and 1923 while a member of the United States Coal Commission. Thus he has been at the head of the Geological Survey for almost half of its existence, during a time of rapidly growing public and industrial recognition of the value of geology in the practical affairs of the Nation. To him the Geological Survey owes much for his example of unswerving official integrity and for his insistence upon loyalty to the ideals of public service. The practical application of science to the public welfare was his objective throughout his directorship—an objective to be attained only by a constant search for facts and by their accurate and fearless statement. Introduction of sound business methods and the encouragement of cordial relations with the public were factors in the smooth functioning of the organization during his incumbency.

Under Director Smith's administration the Geological Survey has grown greatly in the extent and scope of its activities. During the fiscal year 1931 the direct Federal appropriations were nearly twice and the total funds available from Federal and State sources for work by and under supervision of the Geological Survey were nearly

three times as large as the corresponding funds in 1907, the first year of his directorship.

The selection of Doctor Smith by the President to head the Federal Power Commission was a recognition of his success as an administrator and of the important position that the Geological Survey has taken for years under his direction in the conservation of water and power resources and their development in the public interest.

PUBLICATIONS OF THE YEAR

The following publications were issued during the fiscal year 1931:

ANNUAL REPORT

Fifty-first Annual Report of the Director of the Geological Survey.

PROFESSIONAL PAPERS

- 100. The coal fields of the United States, by M. R. Campbell and J. A. Bownocker.
- 159. The Upper Cretaceous floras of Alaska, by Arthur Hollick, with a description of the plant-bearing beds, by G. C. Martin.
- 160. Geologic history of the Yosemite Valley, by F. E. Matthes.
- 165-D. Geology of the Big Snowy Mountains, Mont., by Frank Reeves.
- 165-E. The kaolin minerals, by C. S. Ross and P. F. Kerr.

BULLETINS

- 812. Contributions to economic geology (short papers and preliminary reports). 1929, Part II, Mineral fuels.
- 813. Mineral resources of Alaska, report on progress of investigations in 1928, by P. S. Smith and others.
- 813-D. Notes on the geology of upper Nisina River, by F. H. Moffit.
- 814. Geology and ore deposits of the Wood River region, Idaho, by J. B. Umpleby, L. G. Westgate, and C. P. Ross, with a description of the Minnie Moore and near-by mines, by D. F. Hewett.
- 815. Geology and mineral resources of northwestern Alaska, by P. S. Smith and J. B. Mertie, jr.
- 817. Boundaries, areas, geographic centers, and altitudes of the United States and the several States, with a brief record of important changes in their territory and government (2d edition), by E. M. Douglas.
- 819. The Wasatch Plateau coal field, Utah, by E. M. Spieker.
- 820. Nitrate deposits in southeastern California, with notes on deposits in southeastern Arizona and southwestern New Mexico, by L. F. Noble.
- 821. Contributions to economic geology (short papers and preliminary reports). 1930, Part I, Metals and nonmetals except fuels.
- 821-A. A graphic history of metal mining in Idaho, by C. P. Ross.
- 821-B. A geologic study of the Madden Dam project, Alhajuela, Canal Zone, by Frank Reeves and C. P. Ross.
- 821-C. Iron ore on Canyon Creek, Fort Apache Indian Reservation, Ariz., by E. F. Burchard.
- 822. Contributions to economic geology (short papers and preliminary reports). 1930, Part II, Mineral fuels.
- 822-A. Geology and mineral resources of parts of Carbon, Big Horn, Yellowstone, and Stillwater Counties, Mont., by R. S. Knappen and G. F. Moulton.
- 822-C. Bituminous sandstone near Vernal, Utah, by E. M. Spieker.
- 823. Bibliography of North American geology, 1919-1928, by J. M. Nickles.
- 824-A. Mineral industry of Alaska in 1929 and administrative report, by P. S. Smith.
- 825. Microscopic determination of the ore minerals, by M. N. Short.
- 826. Names and definitions of the geologic units of California, by M. G. Wilmarth.

WATER-SUPPLY PAPERS

620. Geology and ground-water resources of western Sandoval County, N. Mex., by B. C. Renick.
622. Surface-water supply of the United States, 1926, Part II, South Atlantic slope and eastern Gulf of Mexico basins.
623. Surface-water supply of the United States, 1926, Part III, Ohio River Basin.
628. Surface-water supply of the United States, 1926, Part VIII, Western Gulf of Mexico basins.
630. Surface-water supply of the United States, 1926, Part X, The Great Basin.
631. Surface-water supply of the United States, 1926, Part XI, Pacific slope basins in California.
633. Surface-water supply of the United States, 1926, Part XII, North Pacific slope drainage basins: B, Snake River Basin.
634. Surface-water supply of the United States, 1926, Part XII, North Pacific slope basins; C, Pacific slope basins in Oregon; and lower Columbia River Basin.
635. Surface-water supply of Hawaii, July 1, 1925, to June 30, 1926.
636. Contributions to the hydrology of the United States, 1929.
- 637-B. Preliminary report on the ground-water supply of Mimbres Valley, N. Mex., by W. N. White.
- 637-C. Water-power resources of the McKenzie River and its tributaries, Oreg., by B. E. Jones and H. T. Stearns.
641. Surface water supply of the United States, 1927, Part I, North Atlantic slope drainage basins.
643. Surface water supply of the United States, 1927, Part III, Ohio River Basin.
644. Surface water supply of the United States, 1927, Part IV, St. Lawrence River Basin.
645. Surface water supply of the United States, 1927, Part V, Hudson Bay and upper Mississippi River basins.
646. Surface water supply of the United States, 1927, Part VI, Missouri River Basin.
647. Surface water supply of the United States, 1927, Part VII, Lower Mississippi River Basin.
648. Surface water supply of the United States, 1927, Part VIII, Western Gulf of Mexico basins.
649. Surface water supply of the United States, 1927, Part IX, Colorado River Basin.
650. Surface water supply of the United States, 1927, Part X, The Great Basin.
655. Surface water supply of Hawaii, July 1, 1926, to June 30, 1927.

TOPOGRAPHIC AND OTHER MAPS

[The figures in parentheses indicate limiting parallels and meridians of the areas covered]

Alabama:

Montgomery (32° 15'-32° 30'; 86° 15'-86° 30').

Arizona:

Agulla Mountains (32° 30'-32° 45'; 113° 15'-113° 30').

Hyder (33°-33° 15'; 113° 15'-113° 30').

Kim (32° 30'-32° 45'; 113° 30'-113° 45').

Linskey (33° 45'-34°; 114°-114° 15').

Stoval (32° 45'-33°; 113° 30'-113° 45').

California:

Compton (33° 48'-33° 54'; 118° 12'-118° 18').

Hamlin School (35° 37' 30''-35° 45'; 119° 22' 30''-119° 30').

Leonards (35° 30'-35° 37' 30''; 119° 22' 30''-119° 30').

McFarland (35° 37' 30''-35° 45'; 119° 7' 30''-119° 15').

Miramonte Ranch (35° 37' 30''-35° 45''; 119° 30'-119° 37' 30'').

Naval Petroleum Reserve No. 1 (Elk Hills oil field) (35° 13' 30''-35° 20'; 119° 18'-119° 35').

Pond (35° 37' 30''-35° 45'; 119° 15'-119° 22' 30'').

Wasco (35° 30'-35° 37' 30''; 119° 15'-119° 22' 30'').

Colorado:

Glenwood Springs (39° 30'-40°; 107°-107° 30').

State, scale 1 inch=8 miles.

Delaware (see Delaware-Maryland; Delaware-New Jersey; New Jersey-Delaware).

Delaware-Maryland:

Wyoming ($39^{\circ} 30' - 39^{\circ} 15'$; $75^{\circ} 30' - 75^{\circ} 45'$).

Delaware-New Jersey (see also New Jersey-Delaware):

Smyrna ($39^{\circ} 15' - 39^{\circ} 30'$; $75^{\circ} 30' - 75^{\circ} 45'$).

District of Columbia (see Maryland-Virginia-District of Columbia).

Hawaii:

Huamoula ($19^{\circ} 30' - 19^{\circ} 45'$; $155^{\circ} 15' - 155^{\circ} 30'$).

Kaohoe ($19^{\circ} 30' - 19^{\circ} 45'$; $155^{\circ} 30' - 155^{\circ} 45'$).

Idaho (see Wyoming-Montana-Idaho).

Illinois (see also Illinois-Missouri):

Danvers ($40^{\circ} 30' - 40^{\circ} 45'$; $89^{\circ} 30' - 89^{\circ} 45'$).

Glasford ($40^{\circ} 30' - 40^{\circ} 45'$; $89^{\circ} 45' - 90^{\circ}$).

Hardin ($39^{\circ} 30' - 39^{\circ} 45'$; $90^{\circ} 30' - 90^{\circ} 45'$).

Nebo ($39^{\circ} 15' - 39^{\circ} 30'$; $90^{\circ} 45' - 91^{\circ}$).

Normal ($40^{\circ} 30' - 40^{\circ} 45'$; $88^{\circ} 45' - 89^{\circ}$).

Steger ($41^{\circ} 22' 30'' - 41^{\circ} 30'$; $87^{\circ} 37' 30'' - 87^{\circ} 45'$).

Illinois-Missouri:

Pearl ($39^{\circ} 15' - 39^{\circ} 30'$; $90^{\circ} 30' - 90^{\circ} 45'$).

Indiana (see Michigan-Indiana).

Iowa:

Mitchellville ($41^{\circ} 30' - 41^{\circ} 45'$; $93^{\circ} 15' - 93^{\circ} 30'$).

Maine (see also Maine-New Hampshire):

Rumford ($44^{\circ} 30' - 44^{\circ} 45'$; $70^{\circ} 30' - 70^{\circ} 45'$).

Sandy Bay ($45^{\circ} 45' - 46^{\circ}$; $70^{\circ} 15' - 70^{\circ} 30'$).

Square Lake ($47^{\circ} - 47^{\circ} 15'$; $68^{\circ} 15' - 68^{\circ} 30'$).

Stockholm ($47^{\circ} - 47^{\circ} 15'$; $68^{\circ} - 68^{\circ} 15'$).

Winterville ($46^{\circ} 45' - 47^{\circ}$; $68^{\circ} 30' - 68^{\circ} 45'$).

Maine-New Hampshire:

Moose Bog ($45^{\circ} 15' - 45^{\circ} 30'$; $71^{\circ} - 71^{\circ} 15'$).

Maryland (see Delaware-Maryland; Maryland-Virginia-District of Columbia).

Maryland-Virginia-District of Columbia:

Washington and vicinity (road map) ($38^{\circ} 30' - 39^{\circ} 30'$; $76^{\circ} 30' - 77^{\circ} 30'$),
scale 1 inch = 4 miles.

Michigan (see also Michigan-Indiana):

Benton Harbor ($42^{\circ} - 42^{\circ} 15'$; $86^{\circ} 15' - 86^{\circ} 30'$).

Fennville ($42^{\circ} 30' - 42^{\circ} 45'$; $86^{\circ} - 86^{\circ} 15'$).

Hartford ($42^{\circ} - 42^{\circ} 15'$; $86^{\circ} - 86^{\circ} 15'$).

South Haven ($42^{\circ} 15' - 42^{\circ} 30'$; $86^{\circ} 15' - 86^{\circ} 30'$).

Michigan-Indiana:

Niles ($41^{\circ} 45' - 42^{\circ}$; $86^{\circ} 15' - 86^{\circ} 30'$).

Minnesota (see Wisconsin-Minnesota).

Missouri (see also Illinois-Missouri):

Coldwater ($37^{\circ} 15' - 37^{\circ} 30'$; $90^{\circ} 15' - 90^{\circ} 30'$).

Montana (see Wyoming-Montana-Idaho).

New Hampshire (see also Maine-New Hampshire; Vermont-New Hampshire):

Cardigan ($43^{\circ} 30' - 43^{\circ} 45'$; $71^{\circ} 45' - 72^{\circ}$).

New Jersey-Delaware (see also Delaware-New Jersey):

Bay Side ($39^{\circ} 15' - 39^{\circ} 30'$; $75^{\circ} 15' - 75^{\circ} 30'$).

New Mexico:

Tucumcari ($35^{\circ} - 35^{\circ} 30'$; $103^{\circ} 30' - 104^{\circ}$).

North Dakota:

Devils Lake ($48^{\circ} - 48^{\circ} 15'$; $98^{\circ} 45' - 99^{\circ}$).

Drake ($47^{\circ} 45' - 48^{\circ}$; $100^{\circ} 15' - 100^{\circ} 30'$).

Hamar ($47^{\circ} 45' - 48^{\circ}$; $98^{\circ} 30' - 98^{\circ} 45'$).

Pekin ($47^{\circ} 45' - 48^{\circ}$; $98^{\circ} 15' - 98^{\circ} 30'$).

Oklahoma:

McLoud ($35^{\circ} 15' - 35^{\circ} 30'$; $97^{\circ} - 97^{\circ} 15'$).

Oregon:

Mount Jefferson ($44^{\circ} 30' - 45^{\circ}$; $121^{\circ} 30' - 122^{\circ}$).

Pennsylvania:

Tidioute ($41^{\circ} 30' - 41^{\circ} 45'$; $79^{\circ} 15' - 79^{\circ} 30'$).

Tennessee:

Erin ($36^{\circ} 15' - 36^{\circ} 30'$; $87^{\circ} 30' - 87^{\circ} 45'$).

Texas:

Bassett (33° 15'–33° 30'; 94° 30'–94° 45').
 Belton (31°–31° 15'; 97° 15'–97° 30').
 Carrollton (32° 45'–33°; 96° 45'–97°).
 Grapevine (32° 45'–33°; 97°–97° 15').
 Ivan (32° 45'–33°; 98° 30'–98° 45').
 Killeen (31°–31° 15'; 97° 30'–97° 45').
 Lockhart (29° 45'–30°; 97° 30'–97° 45').
 Richland Springs (31° 15'–31° 30'; 98° 45'–99°).
 Santo (32° 30'–32° 45'; 98°–98° 15').
 Seguin (29° 30'–29° 45'; 97° 45'–98°).
 State, oil and gas fields, scale 1:750,000. 2 sheets.
 Tilden (28° 15'–28° 30'; 98° 30'–98° 45').
 Tolar (32° 15'–32° 30'; 97° 45'–98°).
 Tordia (28° 45'–29°; 98°–98° 15').
 Whitsett (28° 30'–28° 45'; 98° 15'–98° 30').

Vermont (see also Vermont-New Hampshire):

Hyde Park (44° 30'–44° 45'; 72° 30'–72° 45').

Vermont-New Hampshire:

Bellows Falls (43°–43° 15'; 72° 15'–72° 30')

Virginia (see also Maryland-Virginia-District of Columbia):

Max Meadows (36° 45'–37°; 80° 45'–81°).
 Speedwell (36° 45'–37°; 81°–81° 15').
 University (38°–38° 15'; 78° 30'–78° 45').
 Warrenton (38° 30'–38° 45'; 77° 45'–78°).

Washington:

Chewelah (48°–48° 30'; 117° 30'–118°).
 Steamboat Mountain (46°–46° 30'; 121° 30'–122°).

Wisconsin-Minnesota:

La Crosse (43° 45'–44°; 91°–91° 15').

Wyoming (see also Wyoming-Montana-Idaho):

State, oil and gas fields, scale 1 inch=8 miles.

Wyoming-Montana-Idaho:

Yellowstone National Park (44° 10'–45°; 109° 50'–111° 5') scale 1 inch=2 miles.

THE YEAR'S OPERATIONS

Among the outstanding publications of the year are Professional Paper 160, on the geologic history of the Yosemite Valley, setting forth the results of years of study by a geologist who is expert at interpreting land forms; Bulletin 817, a revised edition of the fascinating story of the boundaries of the United States and the several States; Bulletin 823, a cumulated bibliography of North American geology for 1919–1928, supplementing the indispensable bibliography for 1785–1918 contained in Bulletins 746 and 747; and Bulletin 825, a detailed description of methods that have proved satisfactory in the microscopic determination of the ore minerals, with tables showing distinctive properties of the minerals and an account of short cuts that may be used in identifying them.

A summary of the year's operations is given below.

GEOLOGIC WORK

Research in geologic science, which has always formed an essential part of the Geological Survey's work but has been relatively overshadowed by the greatly increased demand for work in applied geology, has been expanded by means of the new item for that specific purpose included in the annual appropriation act, providing a fund of \$100,000.

The special 5-year potash exploration program authorized in 1926 was completed, four sites for core tests having been recommended by the Geological Survey to the Bureau of Mines during the year—two in New Mexico, one in

Texas, and one in Washington. The total number of sites thus recommended during the five years is 24, all but one in New Mexico and Texas. As a result of these explorations one company has sunk a shaft and begun commercial production in the New Mexico field. The geologic conditions of the areas investigated are similar to those of the German potash area, and substantial bodies of certain potash minerals that are apparently thick enough, rich enough, and shallow enough to justify extensive mining operations have been discovered.

Geologic work was done in 38 States and Hawaii, and in this work many State and Government agencies and nongovernmental scientific organizations continued to cooperate.

EXPLORATIONS IN ALASKA

The work of the Geological Survey in Alaska is in large part pioneer service under frontier conditions, though airplanes are being used for transportation to some of the remote camps. In the field season of 1930 an area of 944 square miles in southeastern Alaska was topographically mapped on a drainage base compiled from the Navy Department aerial photographs; the Taku district, east of Juneau, was examined in view of the recent discovery of ore deposits there; parts of the Kantishna and Bonnichfield districts and the Alaska Range were studied with the object of finding tonnage for the Alaska Railroad; an area of 2,400 square miles in southwestern Alaska north of Bristol Bay was surveyed topographically; and the drainage and geologic features of 500 square miles between the Yukon and Porcupine Rivers were mapped on a reconnaissance scale. The broad survey of recent mining developments, the collection of mining statistics, and the supervision of operations under coal and oil leases on Government lands were continued. Progress in compiling drainage maps from the Navy Department aerial photographs added about 1,000 square miles to the areas thus covered.

At the end of the fiscal year work had been started on eight field projects, including reconnaissance topographic mapping and mining studies in southeastern Alaska and the Copper River Valley; geologic investigations near Glacier Bay, in the Alaska Range, and in the Yukon-Tanana region; and geologic and topographic surveys in southwestern Alaska. In addition to these projects an extensive investigation has been begun under a special appropriation to the Alaska Railroad to discover resources that may contribute to railroad tonnage, funds being transferred to the Geological Survey for this purpose. Under this project examinations are being made in eight specific areas, besides a general study of nonmetallic mineral resources throughout the railroad belt.

TOPOGRAPHIC MAPPING

The topographic maps prepared as an essential base for detailed geologic mapping have proved to have hundreds of other uses, and the general realization of their value is shown in the increasing funds made available by States and other Federal units for cooperation in this work. The State cooperative funds during the year amounted to \$428,781.88, and were furnished by 21 States, 2 counties, and Hawaii. The area mapped during the year amounted to 18,283 square miles, and the total area now mapped is 1,356,988 square miles. Nine States, the District of Columbia, and Hawaii are completely mapped, and the percentages in the other States range from 8 in Florida to 98.6 in New Hampshire. Of the continental United States, exclusive of Alaska, 44.6 per cent has been mapped. Compilation of culture and drainage maps from aerial photographs was continued, the increasing use of these photographs attesting to the value of this new adjunct to topographic mapping. Surveys of the proposed Great Smoky Mountain National Park were continued, and surveys of the proposed Shenandoah and Mammoth Cave National Parks were completed. There was a large increase in the number of surveys requested by other departments and bureaus, including the Navy Department, War Department, Department of Justice, Forest Service, Corps of Engineers, National Park Service, Federal Power Commission, and Indian Service.

INVESTIGATIONS OF WATER RESOURCES

The work on water resources consists primarily of research and investigation—the collection of facts in regard to the quantity, quality, availability, and utilization of water. The widespread interest in the availability of water

for many uses has led to a persistent and increasing demand for reliable data that would serve as a basis for safe and sane developments. The work is done largely in cooperation with other Government organizations, with State, county, and municipal agencies, and with permittees and licensees of the Federal Power Commission. The amount expended by State, county, and municipal agencies for such work during the year, in part directly and in part through the Geological Survey, was \$461,649.72. This sum covered work in 40 States and Hawaii. Including the cooperative work, the study of surface waters, which consists primarily of the measurement of the flow of streams, was carried on in 47 States, the District of Columbia, and Hawaii, in which at the end of the year 2,663 gaging stations were being maintained. The work on ground-water resources has been planned to meet the more and more exacting public demand for precise information with increasing need for the water. Investigations relating to ground water or power and reservoir sites were made in 19 States and Hawaii. Research into the principles of hydrology has been continued in order to provide a more secure basis for ground-water investigations. Cooperation was continued with well drillers' associations with a view to developing higher standards and better results in water-well drilling. The work on quality of water involved the examination of 1,667 samples of water. Studies of the dissolved and suspended matter in the Colorado River and its tributaries were continued. The investigations of power resources included the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants.

WORK IN CLASSIFYING AND LEASING PUBLIC LANDS

The classification of public lands with respect to their mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands were continued in 20 States and Alaska. The number of cases involving land classification acted on during the year was 14,774, and the results accomplished include net decreases of 197,490 acres in the area of outstanding coal withdrawals and of 15,475 acres in outstanding petroleum withdrawals. At the end of the year the total area classified as mineral in character amounted to 36,433,446 acres in 14 States and Alaska, and the outstanding mineral withdrawals to 46,366,368 acres in 14 States. Definition of the "known geologic structure" of producing oil and gas fields was continued, and at the end of the year the net area so defined was 778,851 acres in seven States. Investigations to obtain information for classifying public land with respect to its value for the development of water power were made in two States. There was a net decrease of 51,392 acres in the area included in power reserves, making a total of 6,536,473 acres in 21 States and Alaska, on which about 15,000,000 continuous horsepower can be developed. The net decrease in enlarged-homestead designations was 234,644 acres, making a total outstanding of 317,484,582 acres in 14 States, and the net increase in stock-raising homestead designations was 1,232,728 acres, making a total outstanding of 122,778,718 acres in 19 States. There was a net increase of 8,530 acres in public water reserves, and the total outstanding is now 438,353 acres in 12 States. The supervisory work on public lands subject to the mineral leasing laws was increased by the issuance of 140 leases, 253 permits, and 33 licenses, covering 433,278 acres, and decreased by 1,721 cancellations and expirations of leases, permits, and licenses. The production of petroleum on such lands during the year was 23,821,111 barrels, of natural gas 41,962,184,000 cubic feet, and of gasoline 111,499,598 gallons, on which the royalty, rentals, and bonuses amounted to \$3,206,315. The production of coal on such lands was 3,053,189 tons, of phosphate rock 69,055 tons, of potash 4,727 tons, and of sodium salts 30,257 tons, on which the royalty, rentals, and bonuses amounted to \$401,081. Supervision over oil and gas operations on naval petroleum reserves was continued, and the total production was 5,590,418 barrels of petroleum, 5,123,456,000 cubic feet of natural gas, and 22,745,665 gallons of gasoline, on which the royalty value was \$1,255,656. Inspectional, regulatory, and advisory service was rendered in connection with the leasing of mineral deposits on Indian lands in eight States. In general the demands for engineering advice and assistance are increasing as the supervisory duties under the leasing laws are more clearly defined and enlarged and as the competence and impartiality of the supervisors become more widely known.

PUBLICATIONS

There were increases of 15 per cent in the number of manuscript pages edited and of 25 per cent in the number of drawings and photographs prepared for illustrations during the year but decreases of 10 per cent in the number of proofs received and read, of 39 per cent in number of publications issued, and of 36 per cent in number of pages in the new publications. The number of publications in press at the end of the year was 60, as compared with 31 at the end of the fiscal year 1930. There was a decrease of 14 per cent in new or revised maps issued but an increase of 32 per cent in reprinted maps. The publications of the year consisted of 47 books and pamphlets of the regular series, 78 new or revised maps, 192 reprinted maps, a seventh reprint of "Suggestions to authors," and numerous circulars, lists of publications, etc. The total number of pages in the new book publications was 8,047. In addition to the publications in the regular series, 62 brief reports, a few of them accompanied by maps, were issued in mimeographed form as memoranda for the press. The publications distributed numbered 897,431, of which 4,009 folios and 651,907 maps were sold for \$42,788.68.

GEOLOGIC BRANCH

T. W. STANTON, Acting Chief Geologist

ORGANIZATION AND PERSONNEL

- The administration of the geologic branch continued during the year to be conducted through 11 sections, as follows:

Paleontology and stratigraphy, J. B. Reeside, jr., geologist, acting in charge.

Geology of metalliferous deposits, G. F. Loughlin, geologist, in charge.

Geology of areal and nonmetalliferous deposits, G. R. Mansfield, geologist, in charge.

Geology of iron and steel metals, E. F. Burchard, geologist, in charge.

Glacial geology, W. C. Alden, geologist, in charge.

Coastal Plain investigations, L. W. Stephenson, geologist, in charge.

Geology of fuels, H. D. Miser, geologist, in charge.

Volcanology, T. A. Jaggar, jr., volcanologist, in charge.

Petrology, C. S. Ross, geologist, in charge.

Chemistry and physics, R. C. Wells, chemist, in charge.

Geologic map editing, G. W. Stose, geologist, in charge.

On December 23, 1930, W. C. Mendenhall, chief geologist, became acting director, and from that date to the end of the fiscal year T. W. Stanton was acting chief geologist and J. B. Reeside, jr., succeeded Mr. Stanton in charge of the section of paleontology and stratigraphy.

The professional force at the end of the year included 134 geologists of various grades, many of whom are not employed continuously, 9 chemists, and 3 physicists. During the year there were 2 reinstatements (1 senior geologist and 1 geologist), 22 appointments (1 geologist, 11 assistant geologists, 7 junior geologists, 2 chemists, and 1 physicist), 1 resignation, and 2 transfers to other branches in the Geological Survey. On May 16 there were six transfers to temporary duty in the Alaskan branch. The subprofessional force comprises 7 draftsmen (2 temporary), 1 chief scientific aid, 12 scientific aids, 2 scientific helpers, and 1 skilled laborer, the changes being 8 appointments (2 draftsmen, 4 scientific aids, and 2 scientific helpers) and 1 resignation (scientific aid). In the clerical force there were 7 accessions and 4 separations, leaving a total of 30 clerks of various grades. 3 of whom are temporary.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the geologic branch for the fiscal year were as follows:

Geologic surveys.....	\$400, 000
Research in geologic science.....	100, 000
Volcanologic surveys.....	21, 000
Classification of lands.....	17, 000
Investigating potash deposits.....	12, 500
Repayments from other Federal departments.....	1, 480
Repayments from State and other cooperating organizations	48, 599
	<hr/> 600, 559

The expenditures from these funds may be classified approximately as follows:

Geologic investigations (economic and scientific, including volcanologic).....	\$477, 741
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc.....	115, 221
Unexpended balances.....	7, 597
	<hr/> 600, 559

FUNDAMENTAL RESEARCH IN GEOLOGIC SCIENCE

In the Geological Survey appropriation for the fiscal year 1931 there was a new item, "For fundamental research in geologic science, \$100,000." This does not mean that research in geologic science had been neglected throughout the previous 51 years of the Geological Survey's existence. From the very beginning part of its energy has been devoted to the development of the general principles and the discovery of the fundamental facts on which the science of geology is based. The nature of the work and the character of the men engaged in it have made this necessary. The description of a mineral deposit of economic importance involves not only its present character and extent but also some discussion of how and why and when it was formed and what change it has since undergone. The mapping of the glacial deposits that are so widely distributed in the northern part of the country and at high altitudes farther south has naturally led to the working out of the very complex history of glaciation on this continent. The search for oil, gas, coal, and other needed materials associated with sedimentary rocks has called for very detailed studies of the stratigraphy and lithology of such rocks and of the structure developed in them by earth movements. The now well-known fact that throughout geologic time, so far as sedimentary history is concerned, there has been a regular succession of faunas and floras on the land and in the sea has justified detailed work in paleontology as a means of determining the succession and correlation of stratified rocks over wide areas and as an aid in dating other geologic events, such as mountain building, mineralization, and faulting. It has been necessary to study the chemical and mineral composition of igneous rocks and their alteration by weathering or metamorphism. Popular interest has called for the description and

explanation of great scenic features such as the Yosemite Valley and Yellowstone National Park. All these are research, and they with similar studies have all been carried on by the Geological Survey so far as its means would allow throughout its history, but as the population of the country has grown and the use of our mineral resources has very greatly increased, the demands on the Geological Survey for work in applied geology have increased far more rapidly than the funds and trained personnel. For these reasons the work in pure research has proportionally decreased rather than increased during the last quarter of a century.

The increased appropriation this year for geologic surveys and the added item for fundamental research have permitted the Geological Survey to make some expansion of its ordinary activities in geologic investigation and to begin work on a comparatively small number of research problems selected from a much larger number that have long awaited study but have been necessarily postponed because neither funds nor properly trained personnel were available. The research funds were allotted to six of the administrative sections approximately as follows:

Paleontology and stratigraphy.....	\$42, 000
Geology of areal and nonmetalliferous deposits.....	13, 000
Glacial geology.....	13, 000
Coastal Plain investigations.....	14, 000
Petrology.....	8, 000
Chemistry and physics.....	10, 000
	<hr/>
	100, 000

The principal research projects financed by this fund are as follows:

- Cenozoic, Mesozoic, and Paleozoic stratigraphic paleontology, including both animals and plants.
- Cretaceous and Tertiary micropaleontology.
- Stratigraphy and paleontology of the Atlantic and Gulf Coastal Plain.
- Geology of the Marathon Basin, Texas—a lower Paleozoic basin in a Cretaceous area.
- Southern California batholiths.
- The San Andreas rift zone.
- Geology and geography of Death Valley, Calif.
- Glacial geology of the northern Rocky Mountain region.
- Physiographic history and development of the Mississippi River.
- Mineralogy of the potash minerals and of the southern California pegmatites.
- Spectrographic study of minerals for the detection of rare elements.
- Petrography of sedimentary rocks.
- Development of methods of study of polished sections by reflected light.
- The microstructure of clays.
- Siliceous sediments of the Monterey group in California.

With the carefully selected additions already made to the professional and technical staff and their training in Geological Survey methods during the year and with a considerable number of competent specialists now available for additional appointments when increased funds are provided, the geologic branch is prepared for further effective and much needed expansion both in geologic surveys, most of which necessarily involve research, and in the fundamental research on which all geologic work must be based.

POTASH INVESTIGATIONS

The fifth and last year of the special potash exploration program authorized under the act approved June 25, 1926 (44 Stat. 768), and amended March 3, 1927 (44 Stat. 13888), was ended June 30, 1931. Under this program, which was carried out in cooperation with the Bureau of Mines, the Geological Survey selected and transmitted to the Bureau of Mines the locations for 24 core-test holes, to be drilled under the auspices of the Bureau of Mines. Thirteen of these sites were in New Mexico—1 in Chaves County, 7 in Eddy County, and 5 in Lea County; 10 in Texas—2 each in Crockett and Upton Counties, and 1 each in Crane, Ector, Glasscock, Loving, Reagan, and Winkler Counties; and 1 in Utah, in Grand County. As indicated by the location of the sites selected, areas in New Mexico and Texas were considered most promising for the discovery of commercial potash beds, and the explorations were accordingly confined chiefly to those States. The Permian salt basin of southeastern New Mexico and western Texas is geologically similar to the German potash area, and notable showings of potash had been obtained from numerous wells drilled for oil in that region. Showings of rich potash salts had also been disclosed, however, in several wells in Grand County, Utah, in a field in which the structural conditions are similar to those of the German potash field, and one site for core drilling was therefore selected in that area near the end of the drilling program.

During the year ended June 30, 1931, recommendations for 4 of the Government wells—2 in Eddy County, N. Mex., 1 in Lea County, N. Mex., and 1 in Grand County, Utah—were submitted to the Bureau of Mines. One of these wells, located in Eddy County, was completed during the year, as were 3 wells—1 in Loving County, Tex., and 2 in Lea County, N. Mex.—for which recommendations had been submitted to the Bureau of Mines during the preceding year. Two press notices giving the results of chemical and mineralogical tests of the cores from the fifteenth, sixteenth, seventeenth, and eighteenth Government tests, located, respectively, in Eddy, Chaves, and Lea Counties, N. Mex., and Loving County, Tex., were published.

An important development during the year was the completion of the shaft of the United States Potash Co. in sec. 12, T. 21 S., R. 29 E., Eddy County, N. Mex., and the beginning of commercial production by that company. Detailed analytical and mineralogical work on samples from this shaft has been done in the chemical laboratory of the Geological Survey.

The most abundant potash mineral found in all the tests made by the Government and by private companies in the salt basin in New Mexico and Texas is polyhalite. Substantial bodies of this mineral of a grade comparable with that of salts mined abroad, or better, have been found at several localities. Core tests in New Mexico also indicate that large bodies of the more acceptable chloride salt sylvite are present in that State and that some of them are apparently thick enough, rich enough, and shallow enough to justify mining operations. Other potash minerals recognized in the region are carnallite, kainite, langbeinite, and leonite.

INTERNATIONAL GEOLOGICAL CONGRESS

Guidebooks for the excursions of the International Geological Congress to be held in Washington in 1933 are being prepared by members of the Geological Survey and other geologists. Most of the guidebooks contain contributions by several authors.

GEOLOGIC MAP OF THE UNITED STATES

The compilation and preparation of a geologic map of the United States on a scale of 1:2,500,000, which was begun about two years ago, was pushed with more vigor during the year. By the end of the year maps of 36 States were finished, and considerable progress was made on the rest. The engraving of geologic boundaries was begun.

*WORK IN GEOLOGY BY STATES**ALABAMA*

Further field studies of deposits of red iron ore in Etowah and St. Clair Counties and of deposits of brown iron ore in Bibb, Chilton, Clay, Coosa, Shelby, Talladega, and Tallapoosa Counties were made by E. F. Burchard in connection with his studies of the iron ores of the State in cooperation with the Geological Survey of Alabama. A report on the red iron ores of north-eastern Alabama is nearing completion.

A paper on the economic geology of the Birmingham district has been prepared by E. F. Burchard for inclusion in one of the guidebooks for the International Geological Congress.

D. F. Hewett and E. F. Burchard examined deposits of manganese in Calhoun, Cherokee, and Etowah Counties.

Field investigations of a portion of the Paleozoic region of Alabama were made by Miss A. I. Jonas to gather data for the geologic map of the United States.

C. W. Cooke and Ralph W. Stewart examined type locations of Tertiary formations of Alabama.

ARIZONA

Manganese deposits near Alamo, Ariz., were examined by D. F. Hewett, and a report on them, with B. N. Webber as joint author, is in preparation.

Examinations of the geology between El Paso, Tex., and San Francisco, Calif., along the route of the Southern Pacific Railroad were made by N. H. Darton for the purpose of preparing a guidebook to the route.

A report on correlation of Jurassic sandstones of southeastern Utah, north-eastern Arizona, southwestern Colorado, and northwestern New Mexico is in preparation by J. B. Reeside, jr., A. A. Baker, and C. H. Dane.

The geology of the Tucson quadrangle is being studied by B. N. Moore for the purpose of revising and bringing up to date a report prepared some time ago by C. F. Tolman.

David White has in preparation a preliminary report on the evidence of plant life in the pre-Cambrian formations of Arizona and Montana. He made a brief visit to the Grand Canyon in September, 1930.

Publications: Bulletins 820, 821-C. (See p. 4.)

ARKANSAS

The report on the geology and lead and zinc deposits of northern Arkansas by E. T. McKnight, prepared under cooperative agreement with the Arkansas Geological Survey, is nearing completion. Further field studies of some stratigraphic problems were made in the area by Mr. McKnight in company with H. D. Miser, who conferred with him about problems of correlation.

A paper on the stratigraphy of the St. Peter sandstone and related formations in northern Arkansas is being written by E. T. McKnight.

The diamond mines near Murfreesboro, Pike County, were visited by H. D. Miser to note the new mining development. He also made a brief examination

of manganese deposits at Batesville, and he has in preparation a paper on compaction of sediments at the Cason manganese mine, Batesville, for publication by the American Association of Petroleum Geologists.

David White, H. D. Miser, and L. G. Henbest spent several days in the Fayetteville region studying the formations of Carboniferous age with the object of making correlations between the Ozark and Ouachita regions, and C. B. Read collected coal samples and fossil plants from the Arkansas coal fields.

Studies of the Morrow formation of Arkansas and Oklahoma were made by G. H. Girty, who also continued work on the fauna of the Batesville sandstone.

H. D. Miser, together with several midcontinent geologists, prepared a road log for the 1931 field trip of the Kansas Geological Survey through the Ouachita Mountains of Arkansas and Oklahoma, and with P. B. King and C. S. Ross he held a field conference in the Ouachita Mountains.

A paper on pre-Cretaceous rocks found in wells in the part of the Gulf Coastal Plain south of the Ouachita Mountains was submitted by H. D. Miser and E. H. Sellards for publication in the bulletin of the American Association of Petroleum Geologists.

CALIFORNIA

Further field studies in continuation of the investigations and report began some time ago by W. S. W. Kew in the San Pedro Hills area were conducted by W. P. Woodring, who completed field examinations of the area and made progress on the report. Mr. Woodring is also preparing a guidebook covering the hills for the International Geological Congress. A paper by Messrs. Woodring and Kew on Tertiary and Pleistocene deposits of the San Pedro Hills was submitted for publication in the proceedings of the Geological Society of Washington. Mr. Woodring also submitted a paper, "*Epitonium fallaciosum*," for publication in Nautilus.

A stratigraphic and structural study of the Kettleman Hills oil and gas fields is being made by W. P. Woodring and Ralph Stewart, who are studying the surface structure and stratigraphy, and Ralph Richards, who is studying the subsurface and economic phases of the field.

A revised map showing the oil and gas fields of California is in preparation by G. B. Richardson.

The southern California batholiths are being studied by E. S. Larsen. In this work he has completed the detailed mapping of the southeast corner of the San Luis Rey quadrangle.

Field and office studies of the San Andreas rift region were continued by L. F. Noble and C. L. Gazin.

A reconnaissance trip into Death Valley was made by L. F. Noble, W. C. Mendenhall, and H. G. Ferguson for the purpose of outlining future work in the valley.

A scientific study of the siliceous sediments and associated rocks of the Monterey group was started by M. N. Bramlette. In this connection he examined stratigraphic sections of Miocene deposits in the Los Angeles region, measured sections in the Topanga Canyon, in the Santa Monica Mountains, and made reconnaissance examinations in the Santa Maria region, San Joaquin Valley, and Puente Hills.

A report on the geomorphology of the upper San Joaquin Basin by F. E. Matthes is in preparation.

Mr. Matthes is also preparing a paper on the Yosemite region for a guidebook for the International Geological Congress. The guidebook for the Southern Pacific route is noted under Arizona.

A detailed field study of the Grass Valley mining district is in progress by W. D. Johnston, jr., and a report on the geology and ore deposits of the Ivanpah quadrangle, California and Nevada, is in preparation by D. F. Hewett.

Work in the Hawthorne and Tonopah quadrangles, parts of which are in California, is noted under Nevada.

Pumicite deposits near Bishop were examined by G. R. Mansfield to note their mode of occurrence.

The report on the copper deposits of Plumas County by Adolph Knopf is in preparation. In this work he has been assisted on the study of ores in the Engels district by M. N. Short.

A geologic map of the State is being compiled in cooperation with the California Division of Mines.

S. W. Muller made a field study of the Brock shale, Pit shale, and Hosselkus limestone in the Bedding quadrangle.

Work in the Lassen Volcano Observatory at Mineral, in charge of R. H. Finch, consisted of continuous operation of seismographs, observations of temperature of the hot springs, measurements of movements in landslide areas, and studies of certain flows in the Lassen Volcano National Park. Mr. Finch submitted a paper for outside publication on the last lava flow on the mainland of the United States.

Publications: Professional Paper 160; Bulletins 820, 826. (See p. 4.)

COLORADO

Cooperation with the Geological Survey Board of the State of Colorado and the Metal Mining Board in the study of the mining districts of the State was continued under the general supervision of B. S. Butler, and a progress report on cooperative geologic surveys in Colorado for the year 1930 by Mr. Butler has been published by the Colorado Scientific Society.

The study of the mineralized belt of the Front Range was extended by T. S. Lovering northeastward from Breckenridge to Jamestown and included reexamination of features in the Silver Plume, Georgetown, Idaho Springs, and Central City areas and completion of a detailed study of the Nederland tungsten district begun in 1930. The report on the Nederland district is in preparation by Mr. Lovering. E. N. Goddard continued a detailed field study of the Jamestown district.

In the San Juan region work has been continued in the Ouray-Telluride area by W. S. Burbank and E. B. Eckel, and a preliminary report on the structure of the Ouray area by Mr. Burbank has been published. The detailed report on this area has not yet been prepared, as field studies covering the entire region have not yet been completed. Messrs. Burbank and Eckel also made some examinations in the Lake City area, and Messrs. Butler, Burbank, and Eckel did preliminary work in the Silverton district and made examinations in the La Plata and Plume districts with a view to possible future work there. In the Rico district geologic work was started by E. T. McKnight and Mr. Butler. The field work in this district will require another season for completion.

Geologic mapping in the Galena Mountain area was begun by J. W. Vanderwilt early in the year, and a preliminary report on the area was completed for publication by the Colorado Scientific Society. The geology of the Snowmass area as a whole is little known, and geologic mapping must be carried further before it will be possible to judge of the commercial importance of the mineral deposits of the area.

Field work in the Cripple Creek district has been carried on by A. H. Koschmann, bringing to a conclusion the work which G. F. Loughlin has been doing there for several years past. A report on the investigations is under way.

Further field work in an area south of Leadville was done by C. H. Behre, in the Alma region by B. S. Butler and J. D. Singewald, and in the North Platte Gulch area by J. W. Vanderwilt. Detailed reports on the Leadville district by Mr. Behre, the Alma district by Messrs. Singewald and Butler, the Climax district by Messrs. Butler and Vanderwilt, and the North Platte Gulch area, Alma district, by Mr. Vanderwilt, are in preparation for Geological Survey publication. A preliminary geologic map of the Alma mining district, accompanied by a short text, and a paper on the Climax molybdenum deposits by Messrs. Butler and Vanderwilt have been submitted for publication by the Colorado Scientific Society.

Carnotite deposits of southwestern Colorado and southeastern Utah were examined by G. F. Loughlin to obtain information wanted by Congress.

A paper on the molybdenum-quartz veins in Colorado, by J. W. Vanderwilt, was presented at the annual meeting of the Geological Society of America.

A paper on deposition features of the Parting quartzite near Alma, by Q. D. Singewald, was submitted to the American Journal of Science, and another paper, entitled "Alteration as an end phase of igneous intrusion in sills on Loveland Mountain, Park County," by Mr. Singewald, was sent to Economic Geology.

A revision of the general geologic map of western Colorado was started during the year, and Mr. Lovering has made good progress for the northern part of the Front Range. In the preparation of such a map correlation problems of the sedimentary rocks in the different parts of the State have been studied. J. Harlan Johnson has been engaged on a study of the Carboniferous rocks, and J. B. Reeside, jr., and J. S. Williams have made preliminary correlations of the

Mesozoic rocks. A report by Mr. Johnson on the Carboniferous formations of central Colorado is well advanced. David White spent several weeks in a study of special problems in cooperation with several geologists.

A guidebook of the mineralized area of western Colorado for the International Geological Congress is being prepared by Messrs. Burbank and Lovering with the assistance of Messrs. Eckel, Goddard, Johnson, Lang, Singewald, and Vanderwilt.

Further field work was done by E. S. Larsen in the San Juan region to collect additional data for his comprehensive report on the geology of this region.

E. T. McKnight prepared a discussion of a paper by G. E. Collins, entitled "Localization of ore bodies in the San Juan region," for publication by the Colorado Scientific Society.

A report on correlation of the Jurassic sandstones of southeastern Colorado is noted under Arizona.

M. R. Campbell continued preparation of a report on the Mount Harris area, in the Yampa coal field, and of a detailed report covering the whole field. Mr. Campbell spent a little time in the field gathering additional data for the report.

A semidetalled structural reconnaissance examination of the southern part of the Julesburg Basin was begun in June, 1931, by C. H. Dane and W. G. Pierce.

In connection with coal classification work, M. R. Campbell examined coals in the Denver district.

Edwin Kirk completed and submitted for publication in the American Journal of Science papers on early Paleozoic formations of Colorado.

G. H. Girty has in preparation a paper on new species of Carboniferous fossils from Colorado.

J. B. Reeside completed a report on the supposed marine Jurassic Sundance in the foothills of the Front Range for publication by the American Association of Petroleum Geologists.

A chart, in three sheets, giving a correlation of the named geologic units in Colorado, by M. Grace Wilmarth, was issued.

CONNECTICUT

Field and office studies of the geology of portions of eastern Connecticut were made by Mrs. E. B. Knopf in connection with the preparation of material for the revised geologic map of the United States and of material which she is contributing to the guidebook of this section of the country for the International Geological Congress. Mrs. Knopf has also continued her study of metamorphism of crystalline schists in the Clove and Millbrook quadrangles.

DISTRICT OF COLUMBIA

A guidebook for Washington and vicinity for the International Geological Congress is being prepared by M. R. Campbell.

FLORIDA

A second paper on the gastropods of the Alum Bluff group of Florida by Julia Gardner was completed and submitted for publication as Professional Paper 142-G.

A study of Tertiary mollusks from southern Florida was made by W. C. Mansfield, and the results have been embodied in a report that has been submitted for publication in the Proceedings of the United States National Museum. Mr. Mansfield also submitted a paper on Pliocene fossils from limestone in southern Florida for Geological Survey publication.

Field work in collecting fossils and geologic data on the Tampa limestone in western and north-central Florida was done by W. C. Mansfield in cooperation with the Florida Geological Survey.

GEORGIA

C. W. Cooke and W. H. Monroe continued field mapping of the Cretaceous, Tertiary, and Quaternary formations of the Coastal Plain of Georgia, in cooperation with the Georgia State Geological Survey, and office work on the compilation of material for a geologic map of Georgia. L. W. Stephenson did field work on the Cretaceous of Georgia for this map.

Miss Anna I. Jonas made a study of the crystalline areas of the State to collect data for the revised geologic map of Georgia and the geologic map of the United States.

D. F. Hewett examined manganese deposits at Cartersville.

HAWAII

In the Hawaiian Islands, the headquarters of the volcanologic work of the Survey, T. A. Jaggar, jr., and his assistants continued the study of the volcanic activity in the islands. Constant observations and reports were made of the Halemaumau pit of Kilauea Volcano, where the rim cracks and changes were measured from time to time, and of the activities of Mauna Loa. Seismographs were maintained at three places near Kilauea Volcano and others at Hilo and at Kealahou in the Kona district. Howard Powers continued mapping in the Kona area, and carried on petrographic studies at the observatory. The Hawaiian Volcano Research Association continued cooperation in these studies and in the publication of the "Volcano Letter," issued weekly at the observatory. Seismograph observations, directed by Mr. Jaggar, are maintained also in Alaska, at Kodiak and Dutch Harbor.

IDAHO

Investigations of the geology and ore deposits of south-central Idaho, partly in cooperation with the Idaho Bureau of Mines and Geology, were continued by C. P. Ross. Field examinations were made in the Germania Basin, Warren area, and Marshall Lake district, and mapping of the Bayhorse quadrangle was continued. T. H. Hite, of the Idaho Bureau of Mines, continued work in the Bayhorse quadrangle under Mr. Ross's direction. Edwin Kirk made stratigraphic studies in the Bayhorse quadrangle with Mr. Ross, and reports on the Ordovician, Silurian, and Devonian fossils were prepared by Mr. Kirk and on fossil plants by David White. R. W. Brown reported on fossil plants from the Challis area. Preliminary reports on the Bayhorse quadrangle and on the geology of the Eastern Division, Idaho National Forest, were transmitted to the Idaho Bureau of Mines and Geology for publication, and a paper on classification of lode deposits of south-central Idaho by Mr. Ross was transmitted for publication in *Economic Geology*. Reports on the Dome district, the Marshall Lake and Warren districts, the Boulder Creek district, and some ore deposits in Boise Basin have been prepared by Mr. Ross. A report on the geology and ore deposits of the Casto quadrangle was completed and transmitted for Geological Survey publication. Progress has been made by Mr. Ross on his comprehensive report on the mining districts of south-central Idaho and a report on the geology and ore deposits of the Bayhorse quadrangle. Mr. Ross also compiled material on central Idaho for use in the preparation of the revised geologic map of the United States.

G. R. Mansfield spent a few days on field investigations of the geology and mineral resources of the Ammon and Paradise Valley quadrangles for the purpose of revising previous work and filling in a few gaps in areal and economic geology. Reports on these quadrangles are in preparation. R. W. Brown reported on Cretaceous plants from the Lanes Creek quadrangle for Mr. Mansfield.

Mr. Mansfield has in preparation a guidebook covering southeastern Idaho and northwestern Utah for the International Geological Congress.

An examination of manganese deposits at Lava Hot Springs was made by G. R. Mansfield, who also examined a so-called gold prospect in Montpelier Canyon. Supposed dinosaur remains near Gray's Lake, in the Lanes Creek quadrangle, which proved to be fossil tree trunks, were investigated by Mr. Mansfield.

W. C. Alden, assisted by C. L. Gazin, extended his study of the glacial geology and physiography of Idaho to parts of Boundary, Bonner, Fremont, Madison, and Jefferson Counties. Progress was also made by Mr. Alden on his report on the glacial geology and physiography of northern Idaho, western Montana, and eastern Washington.

Edward Sampson resumed the preparation of a report on geology and ore deposits of the Pend Oreille district, northern Idaho, and completed a report on correlation of later pre-Cambrian sediments in the Cordillera near the forty-ninth parallel.

Publications: Bulletins 814, 821-A. (See p. 4.)

ILLINOIS

Preparation of a report on the geology of the Hardin and Brussels quadrangles, in cooperation with the Illinois Geological Survey, was continued by W. W. Rubey. Mr. Rubey prepared an abstract on the Illinois River a problem

in channel equilibrium for publication in the journal of the Washington Academy of Sciences. Edwin Kirk reported on Ordovician invertebrate fossils for Mr. Rubey.

Cooperative investigations of the Pottsville floras of Illinois were continued by David White.

Stratigraphic studies were made by Edwin Kirk in the vicinity of Galena, Scales Mount, Apple River, and Stockton.

INDIANA

A report on two new crinoid genera from the Devonian and Silurian of Indiana is in preparation by Edwin Kirk.

David White's studies of the fossil plants from the Pottsville of Illinois were extended into western Indiana.

IOWA

David White's studies of the fossil plants from the Pottsville of Illinois were extended into eastern Iowa.

Rocks of Cambrian to Silurian age were studied in the field by E. O. Ulrich, Edwin Kirk, and E. F. Bean, and those of Ordovician age in the vicinity of Elkader, Guttenberg, and Dubuque were examined by Mr. Kirk, who also studied specimens at the University of Iowa.

G. H. Girty and J. S. Williams revised a manuscript on the Kinderhook fauna.

KANSAS

Studies of the geology of eastern Kansas are being carried on by R. C. Moore for the purpose of furnishing material for the geologic map of the United States and also for a revised geologic map of the State.

J. B. Reeside, jr., joined members of the Kansas Geological Survey for a field conference on the Cretaceous stratigraphy in the western part of the State.

A field and office study of the geology of the Cheyenne Bottoms and adjacent regions, Barton County, was made by N. W. Bass for the Biological Survey, and a report thereon was submitted to that bureau for administrative purposes.

G. R. Mansfield examined pumicite deposits near Fowler and Mead.

KENTUCKY

David White's studies of the fossil plants from the Pottsville of Illinois were extended into western Kentucky.

E. W. Berry prepared a report on fossil plants from the Wilcox group and Jackson formation, and Edwin Kirk has in preparation a paper on crinoids from the Devonian of Kentucky.

LOUISIANA

M. I. Goldman continued studies of salt dome cap rock in preparation of his report on that subject. He prepared for publication in the Bulletin of the American Association of Petroleum Geologists a paper entitled "Bearing of cap rocks on subsidence on the Clay Creek salt dome, Washington County, Tex., and the Chestnut dome, Natchitoches Parish, La.," and a discussion of a paper on the petrography of cap rocks.

Lower Cretaceous invertebrate fossils from deep wells in Louisiana were reported on by T. W. Stanton.

A chart giving a tentative correlation of the named geologic units for Louisiana, by Miss M. Grace Wilmarth, was issued.

MAINE

D. F. Hewett examined manganese deposits at Blue Hill.

MASSACHUSETTS

In connection with the collection of data for the geologic map of the United States Mrs. E. B. Knopf did field work in western Massachusetts.

Additional field work was done by L. M. Prindle in the Greylock quadrangle in connection with geologic studies of the geology of the Taconic area, and progress was made on his report on the region.

A paper on the structural geology of central Massachusetts was prepared by Eugene Callaghan for publication in the Bulletin of the Geological Society of America.

D. F. Hewett examined manganese deposits at West Cummington.

MICHIGAN

E. O. Ulrich with W. O. Hotchkiss made stratigraphic studies of the Lake Superior sandstones between Houghton and a point about 10 miles east of Munising, including Grand Island. Rocks of Cambrian to Silurian age were studied by Mr. Ulrich and Edwin Kirk in cooperation with E. F. Bean, State geologist of Wisconsin.

MINNESOTA

Stratigraphic studies of Paleozoic sections were made by Edwin Kirk in the vicinity of Mantorville, Stewartville, Spring Valley, and Wykoff.

MISSISSIPPI

Field work in the Jackson area has been carried on by W. H. Monroe, partly for the purpose of gathering data regarding the oil and gas possibilities of the area. A preliminary report including a structure contour map and a geologic map have been prepared by Mr. Monroe for publication.

David White examined a portion of the core from a well near Jackson to determine the age of beds from a depth of 4,000 feet.

Well cuttings of Carboniferous age were studied by P. V. Roundy.

An investigation of the Homochitto area was made by C. W. Cooke for the Forest Service.

MISSOURI

G. H. Girty continued revision of a paper on the Warsaw fauna of the Joplin region begun sometime ago in connection with the stratigraphic work of the late C. E. Siebenthal.

A chapter on systematic paleontology, by Josiah Bridge, E. O. Ulrich, and A. F. Foerste, was contributed to the report on the geology of the Eminence and Cardareva quadrangles published by the Missouri Bureau of Geology and Mines.

Messrs. Ulrich and Bridge, accompanied by members of the Bureau of Geology and Mines, made a brief field study of formations of the Upper "Canadian" and Buffalo River group in southeastern Missouri.

Carboniferous microfossils were studied by P. V. Roundy, who also examined Carboniferous well cuttings.

MONTANA

Further field work was done by W. C. Alden in parts of Missoula, Lake, Beaverhead, Flathead, Lincoln, Sanders, Madison, and Gallatin Counties in the course of his investigations of the glacial geology and physiography of western Montana. A report embodying the results of these investigations for several years is in preparation by Mr. Alden.

The field study of the geology and mineral resources of the Libby quadrangle was continued by Russell Gibson, who prepared a preliminary report on the work done, which was issued as a memorandum for the press entitled "Metalliferous deposits near Libby and Troy, Montana." The detailed report of this investigation is in preparation, but further field work is required before it can be completed.

Areal and structural mapping, largely for the purpose of classifying coal lands, was carried on in portions of Rosebud and Custer Counties by W. G. Pierce and party. Mr. Pierce has in preparation a report on the Rosebud coal field for Geological Survey publication, and also a paper on Pleistocene terraces in eastern Montana. A continuation of the investigation of these coal beds eastward to the Powder River in Custer and Powder River Counties was begun in the spring of 1931 by a party in charge of F. S. Parker.

The coal fields in Richland and Dawson Counties were investigated during the summer of 1930 by F. S. Parker, completing the work begun in the spring of 1930, and a report on this work is being prepared by Mr. Parker for Geological Survey publication.

Progress was made by A. J. Collier on his report on the geology of the Little Rocky Mountains and adjacent plains. He also gave some time to the

compilation of data for the Montana State geologic map and the geologic map of the United States.

The report on the Helena mining district by J. T. Pardee and F. C. Schrader is nearing completion.

Stratigraphic studies of Upper Devonian rocks near Logan were made by Edwin Kirk.

Manganese and phosphate deposits near Phillipsburg were examined by J. T. Pardee.

Work by David White on plant life in the pre-Cambrian of Montana is noted under Arizona.

Publications: Professional Paper 165-D, Bulletin 822-A. (See p. 4.)

NEVADA

In the continuation of the cooperative program carried on last year with the Nevada Bureau of Mines in a study of some of the mining regions of the State, additional field mapping and examination of mines was done by H. G. Ferguson and S. W. Muller in the Hawthorne and Tonopah quadrangles and in the Tybo district by W. M. Ferguson. A detailed report covering the work of several years in the Hawthorne and Tonopah quadrangles will be published by the Geological Survey. A preliminary report on the Tybo district is in preparation for publication by the State.

T. B. Nolan, assisted by Ian Campbell, completed field work on a resurvey of the Tonopah district begun last year, and is preparing a detailed report on this district for Geological Survey publication. A preliminary report was issued by the Nevada Bureau of Mines.

Reconnaissance examinations of some mining districts in eastern Nevada were made by F. C. Schrader, and preliminary reports by him covering the Patterson, Cherry Creek, and Spruce Mountain districts were completed and transmitted to the Nevada Bureau of Mines for publication. Mr. Schrader also continued work on a report on the geology and ore deposits at Carson Sink.

A report on "bedded" deposits of manganese oxides near Las Vegas, by D. F. Hewett and B. N. Webber, was transmitted to the Nevada Bureau of Mines for publication.

Office work on a report on the geology and ore deposits of the Ivanpah quadrangle by D. F. Hewett has progressed.

Edwin Kirk prepared a scientific article for outside publication on the Eureka quartzite of Nevada. S. W. Muller has in preparation a paper on the Mesozoic stratigraphy of New York Canyon, Gabbs Valley Range, Mineral County, in connection with which several months' field work was done.

The sodium-sulphate plant at Rhodes Marsh and a deposit of kaolinite near Sodaville were visited by G. R. Mansfield.

David White collected mud samples from the playas near Gerlach.

NEW HAMPSHIRE

Work in the Taconic quadrangle, which lies partly in New Hampshire, is noted under Massachusetts.

NEW JERSEY

A paper by W. T. Schaller on the crystal cavities of the New Jersey zeolite region was transmitted for publication as an Bulletin 832.

M. R. Campbell made a study of the gravel deposits of a portion of New Jersey under a grant from the National Research Council.

NEW MEXICO

Progress was made by A. C. Spencer on his report on the geology and mineral resources of the Santa Rita district and by G. F. Loughlin and A. H. Koschmann on a report on the ore deposits of the Magdalena district.

The Central mining district, Grant County, is being studied by S. G. Lasky in cooperation with the New Mexico Bureau of Mines.

A paper on the Valles Mountain region is in preparation by C. S. Ross.

Field mapping of the coals of the Mesaverde formation of the southern edge of the San Juan Basin in McKinley, Sandoval, and Valencia Counties was continued by a party under the direction of J. D. Sears early in the year and later by C. B. Hunt. A report by Mr. Sears on an area in the southwestern part of the San Juan Basin, mapped in 1929, is in preparation. Mr. Hunt

completed the first draft of a report on the coal and petroleum possibilities in the area mapped in 1930 and has in preparation a paper on the igneous geology of Mount Taylor and vicinity. In the spring of 1931 Mr. Hunt and party extended the field investigation of the coal beds, stratigraphy, and structure of the San Juan Basin to an area adjacent to the south and east sides of Mount Taylor.

G. H. Girty is studying the Abo fauna of La Luz Canyon.

Work in the potash field is reported on page 13.

Investigations for the Southern Pacific guidebook and the correlation of Jurassic sandstones are noted under Arizona.

Publication: Bulletin 820. (See p. 4.)

NEW YORK

Work in the Taconic quadrangle, which lies partly in New York, is noted under Massachusetts, and work in the Clove, Millbrook, Sheffield, and Sandisfield quadrangles is noted under Connecticut.

Mrs. E. B. Knopf continued field and office work in eastern New York in connection with the preparation of material for the geologic map of the United States.

NORTH CAROLINA

Field and office work in the southern Appalachian region was done by Miss A. I. Jonas for the purpose of collecting data for the geologic map of the United States.

NORTH DAKOTA

A study of the Fort Union and associated formations was begun by R. W. Brown and K. J. Murata.

OKLAHOMA

Mapping of the coal deposits, stratigraphy, and structure of the portion of the McAlester quadrangle lying north of the Choctaw fault was carried on by T. A. Hendricks and party in 1930. This investigation was extended in 1931 by Mr. Hendricks, assisted by C. B. Read, to the portion of the Oklahoma coal field lying between the McAlester quadrangle and the Arkansas line.

A report covering the coal-bearing portion of the McAlester quadrangle is in preparation by T. A. Hendricks.

Fossil plants from the Pennsylvanian section in the McAlester quadrangle were studied by C. B. Read in connection with the preparation of a report on the Carboniferous floras of Oklahoma, Texas, and Arkansas.

David White, H. D. Miser, and L. G. Henbest examined the McAlester shale and associated formations in the McAlester and Atoka quadrangles and in the region between Ada and the Arbuckle Mountains. Mr. Miser attended the field conference of the Society of Economic Paleontologists and Mineralogists at Ardmore and joined Dr. C. N. Gould and Dr. E. H. Sellards for a short trip in the Ouachita Mountains.

A paper on pre-Cretaceous rocks found in wells in the part of the Gulf Coastal Plain south of the Ouachita Mountains, by H. D. Miser and E. H. Sellards, was submitted for publication by the American Association of Petroleum Geologists.

E. O. Ulrich and Josiah Bridge, accompanied by members of the Oklahoma Geological Survey, did field work in the Arbuckle Mountains to review the disputed classification and correlation of formations including Taff's Simpson and Viola formations, and Mr. Bridge reported on Cambrian invertebrates from the Arbuckle Mountains.

G. H. Girty continued work on a report on the fauna of the Sycamore limestone, which he is preparing in cooperation with C. L. Cooper, of the Oklahoma Geological Survey, and Edwin Kirk prepared descriptions of Mississippian crinoids for incorporation in this paper.

Preparation of a report on the ostracodes and conodonts of the Sycamore limestone was continued by P. V. Roundy, who also continued his study of other microfossil material.

The study of the Moorefield formation and preparation of a report were continued by G. H. Girty.

Work on the Morrow formation is noted under Arkansas.

A brief examination of forest lands in the Ouachita Mountains, southeast of Oklahoma City, was made by H. D. Miser for the Forest Service.

A chart in four sheets showing the tentative correlation of the named geologic units of Oklahoma, by Miss M. Grace Wilmarth, was issued.

OREGON

Cooperation with the Oregon State Mining Board was continued throughout the year, and a progress report on the cooperative work was issued as a press notice of the Geological Survey. Investigations of the gold, copper, and quicksilver resources in the western part of the State were continued in charge of J. T. Pardee and included completion of studies in the Takilma-Waldo district by P. J. Shenon and party and examinations in the Albright-Turner, Squaw Creek, and Robertson districts. Mr. Shenon has completed drafts of his reports on the geology and ore deposits of the Takilma district and on the geology and ore deposits of the area including the Robertson, Humdinger, and Robert E. gold mines, southwestern Oregon, and has in preparation a third report on the metalliferous deposits in southwestern Oregon, covering other mining districts examined.

The mapping of the Black Butte-Bonanza quicksilver areas was completed by F. G. Wells and party, who also did areal mapping and examined mines in the Meadows district and examined several mines and prospects in an area extending from the vicinity of Tiller to the Rogue River Trail and in small areas containing the Chieftain and Continental gold mines on South Myrtle Creek. The draft of a report on the quicksilver deposits of southwestern Oregon has been completed by Messrs. Wells and Waters.

Examinations of the Bohemia, North Santiam, and Blue River districts by A. F. Buddington and Eugene Callaghan were concluded, and reports on these districts have been prepared.

In the spring and summer of 1931 Eugene Callaghan began a study of the gold lodes of the Cascade Mountains, and J. T. Pardee made an examination of placer deposits along the coast near Bandon.

In eastern Oregon James Gilluly continued his detailed areal mapping and examination of mines of the Baker quadrangle with special reference to the Keating copper district and examined other mining districts in eastern Oregon in which active work was being done. A report on the copper deposits near Keating by Mr. Gilluly has been completed for publication as Bulletin 830-A. A report covering the Baker quadrangle and another on some mining districts of eastern Oregon are in preparation by Messrs. Gilluly and J. C. Reed. A paper on zonal relations of the veins of the Sumpter quadrangle was presented by D. F. Hewett for publication in the Proceedings of the American Institute of Mining and Metallurgical Engineers, and a paper on the replacement origin of the albite granite near Sparta, by James Gilluly, has been prepared for Geological Survey publication.

Investigations of the nonmetallic resources of eastern and central Oregon were carried on by Ralph Richards and B. N. Moore. They included studies of diatomaceous earth in the vicinity of Harper, Malheur County, and Drewsey, Harney County, of limestone in Baker and Wallowa Counties, and of granite, tuff, rhyolite, road metal, volcanic ash, pumice, and potash. The diatomaceous earth and limestone deposits will be the subject of separate reports. Reconnaissance geologic mapping in central and eastern Oregon was also continued by Messrs. Richards and Moore to gather data for use in the compilation of the geologic map of the State and in the preparation of the revised geologic map of the United States.

A paper on the mineral resources of northern California and southern Oregon, by J. T. Pardee, was presented at a meeting of the Northern California-Southern Oregon Development Association at Grants Pass.

PENNSYLVANIA

The report on the geology and mineral resources of the Middletown quadrangle, by G. W. Stose and Anna I. Jonas, was completed and transmitted for publication as a bulletin of the Geological Survey, and progress was made on the detailed geologic reports covering the Tyrone quadrangle, by Charles Butts, and the Butler and Zellenople quadrangles, by G. B. Richardson.

Field and office work for a report on the geology and mineral resources of the Hanover and York quadrangles, a cooperative project with the Pennsylvania Geological Survey, was continued by Mr. Stose and Miss Jonas.

SOUTH CAROLINA

A report by C. W. Cooke on the geology of the Coastal Plain of South Carolina is in preparation.

Work on the geologic map of the State is noted under North Carolina.

SOUTH DAKOTA

Charles B. Read completed a paper on *Pinoxylon dakotense* Knowlton, from the Cretaceous of the Black Hills, for publication in the Botanical Gazette.

E. W. Berry completed a study of fossil plants from the Fuson, New Castle and lower Lance formations.

TENNESSEE

E. F. Burchard prepared new material on the brown iron ore of the western Highland Rim for inclusion in his manuscript on the subject transmitted some time ago for publication by the Tennessee State Geological Survey.

A brief field study of iron ore in Cass and Marion Counties was made by E. F. Burchard, and deposits of manganese ore near Elizabethtown and Cleveland were examined by Mr. Burchard and D. F. Hewett.

Work on the geologic map of the State is noted under North Carolina.

D. F. Hewett and L. W. Currier examined zinc mines at Mascot and Jefferson City in connection with the study of the New River in southern Virginia.

TEXAS

L. W. Stephenson continued field work in some Upper Cretaceous areas of Texas, particularly on the Navarro formation, and continued compilation of the geology of the Coastal Plain of Texas for the geologic map of the State. Progress was made by Mr. Stephenson on his monograph of the Navarro formation, which is being prepared in cooperation with the Texas Bureau of Economic Geology.

N. H. Darton continued field and office work on the geology of western and central Texas for the geologic map.

Miss Julia Gardner continued field and office studies of the Eocene formations of northeastern and southwestern Texas in connection with a general study of the stratigraphy of the Eocene of Texas and to gather material for use in the preparation of the new geologic map of the State.

A paper on the Midway formation of Texas by Miss Gardner, including a chapter on the coral fauna by T. W. Vaughan and Willis P. Popenoe, is in preparation in cooperation with the Texas Geological Survey for publication as a bulletin of the University of Texas. Articles on the relationships of certain faunas to the Midway fauna of Texas by Miss Julia Gardner, on the Yeager clay by Miss Gardner and A. C. Trowbridge, and on the Taylor age of the San Miguel formation of Maverick County by L. W. Stephenson have been published by the American Association of Petroleum Geologists.

Philip King completed his field study of the geology of the Marathon Basin and made progress in the preparation of a report on it. In company with Mr. King, David White made a study of the Pennsylvanian and Permian of western Texas, especially in the Marathon and Glass Mountain area, and Edwin Kirk made stratigraphic and paleontologic studies with Mr. King in the Marathon area. Mr. King presented a paper on the pre-Carboniferous stratigraphy of the Marathon uplift for publication by the American Association of Petroleum Geologists and, together with C. L. Baker and E. H. Sellards, gave a paper on erratic boulders of large size in the western Texas Carboniferous before the meeting of the Geological Society of America at Toronto, in December, 1930. Mr. King began early in the summer of 1931 a detailed study of the geology of the Diablo Plateau area, in which he was assisted by J. Brooke Knight.

Fossil plants from western Texas were reported on by David White for E. H. Sellards, and Cambrian and Ordovician fossils were reported on by Edwin Kirk for Doctor Sellards.

E. O. Ulrich and Josiah Bridge studied the early Paleozoic formations of the central mineral region in cooperation with E. H. Sellards and party, of the Bureau of Economic Geology.

In cooperation with local geologists many localities of the Cretaceous of central Texas were visited by J. A. Cushman, and collections were made in connection with the report on Foraminifera of the Coastal Plain.

M. I. Goldman continued his study of salt dome cap rock and prepared a paper entitled "Bearing of the cap rock on subsidence on the Clay Creek salt dome, Washington County, Texas, and the Chestnut dome, Natchitoches Parish, Louisiana," for publication in the Bulletin of the American Association of Petroleum Geologists.

P. V. Roundy continued his study of Carboniferous microfossils from Texas. A revised oil and gas map of Texas was completed and published.

A chart in three sheets by Miss M. G. Wilmarth, showing the tentative correlation of the named geologic units in Texas, was issued.

Work on the Southern Pacific guidebook is noted under Arizona.

The work in the Texas potash field is described on page 13.

UTAH

The detailed structural and stratigraphic studies in the Green River Desert and adjoining portions of the San Rafael Swell begun last year were continued until October, 1930, by A. A. Baker, and progress was made on a report covering his investigation. Further field studies are being carried on by a party in charge of Mr. Baker.

Mr. Baker continued preparation of his geologic report of the Monument Valley-Navajo region, San Juan County. A preliminary map showing the geologic structure of the region was issued.

A report on the geology of the Salt Valley anticline and the northwestern flank of the Uncompahgre Plateau, Grand County, was prepared by C. H. Dane.

A preliminary map showing the geologic structure of parts of Grand and San Juan Counties by A. A. Baker, C. H. Dane, and E. T. McKnight was issued.

A structure contour map of southeastern Utah is being compiled by A. A. Baker.

Field mapping of the coal, stratigraphy, and structure of a portion of the Wasatch Plateau was continued by E. M. Spieker and party in the summer of 1930 and resumed in the early summer of 1931. The compilation of the map showing the area covered and preparation of the report are in progress but wait further field work before completion.

T. B. Nolan continued office work on his report on the geology and mineral resources of the Gold Hill quadrangle. A paper on an occurrence of badkalt at Gold Hill, Utah, by W. T. Schaller and T. B. Nolan, was submitted for publication in the American Mineralogist. Carnotite deposits of southwestern Colorado and southeastern Utah were investigated by G. F. Loughlin at the request of the Committee on Mines and Mining of Congress.

H. E. Gregory continued his geologic studies of the Colorado Plateau region, southwestern Utah.

A guidebook covering the Colorado Plateau region of Utah for the International Geological Congress was prepared by H. E. Gregory, and a guide to northwestern Utah is being prepared by G. R. Mansfield.

A paper on a new *Pterophyllum* from the Shinarump conglomerate in Utah by W. Berry was submitted for publication in the Journal of the Washington Academy of Sciences.

Work in the Bridger Basin is noted under Wyoming, and work on the correlation of the Jurassic sandstones is noted under Arizona.

Publications: Bulletins 819, 822-C. (See p. 4.)

VERMONT

Work in the Taconic quadrangle, which lies partly in Vermont, is noted under Massachusetts.

VIRGINIA

A study of the New River zinc district in cooperation with the Virginia Geological Survey was begun in the fall of 1930 by L. W. Currier, who with the assistance of H. E. Thomas is continuing detailed mapping and studying the areal geology and mines and prospects of the district.

Manganese deposits at Galax and Scottsville were examined by D. F. Hewett.

L. W. Stephenson, W. C. Mansfield, and C. W. Cooke visited fossil localities and places of geologic interest in the Chesapeake Bay region in connection with the plans for an excursion to this region and the preparation of a guidebook for the International Geological Congress.

Charles Butts has continued areal mapping and study of the Paleozoic formations of the Appalachian Valley of Virginia, in cooperation with the Geo-

logical Survey of Virginia. A guidebook of the Appalachian Valley region of Virginia is being prepared for the International Geological Congress by Mr. Butts.

E. O. Ulrich and Josiah Bridge visited the Porterfield quarries near Saltville and quarries near Marion.

WASHINGTON

Work on the glacial geology and physiography of Washington is noted under Montana.

WISCONSIN

E. O. Ulrich continued descriptions of Wisconsin Upper Cambrian trilobites for inclusion in the monograph by him and C. E. Resser in course of publication by the Milwaukee Public Museum. Part 1 of this monograph has been issued, and Part 2 has been prepared.

WYOMING

Edwin Kirk studied the fossil fauna of the lower Big Horn formation.

In continuation of his studies on the origin and geologic history of Tertiary rocks of the Green River Basin, Wyoming and Utah, a report on which is in progress, W. H. Bradley did further field work on the Bridger, Wasatch, and Green River formations in the southern part of the Bridger Basin of Wyoming and Utah. Some results of this investigation will be embodied in a report on the physiography of the north flank of the Uinta Mountains in Wyoming and Utah.

A detailed study of the geology of the Afton quadrangle was begun by W. H. Rubey, assisted by J. S. Williams, partly for the purpose of classifying the lands as to phosphate.

A new edition of the map of the oil and gas fields of the State was issued.

G. R. Mansfield studied dam sites in the canyon of the Snake River in cooperation with the Forest Service.

A report on the upper Sunshine and lower Sunshine reservoir sites, Park County, was made by T. S. Lovering for the Bureau of Reclamation.

MISSISSIPPI VALLEY

Investigation of the physiographic history of the head of the Mississippi embayment was continued by F. E. Matthes and included studies of the areas about the lower Ohio, Tennessee, and Wabash Rivers.

CANADA

E. O. Ulrich made field studies of the stratigraphy of Paleozoic sections in the vicinity of Phillipsburg, Quebec, and prepared a paper on the Naylor ledge near Phillipsburg, for presentation at the meeting of the Paleontological Society of America at Toronto.

Cretaceous ammonites from Alberta were studied by J. B. Reeside, jr.

GUATEMALA

A paper on reasons why the Mayan cities of the Peten district, Guatemala, were abandoned was prepared by C. W. Cooke.

MEXICO

Lower Cretaceous invertebrate fossils from Mexico were studied by T. W. Stanton.

GENERAL INVESTIGATIONS

Considerable work has been done on stratigraphic, paleontologic, and other subjects that do not relate to individual States. The studies belonging to this class of investigations have related to fossil plants from the Green River formation, by R. W. Brown; the Jackson group, by C. W. Cooke; upper Eocene Foraminifera of the southeastern United States, by J. A. Cushman; Miocene Foraminifera of the Atlantic Coastal Plain, by J. A. Cushman and E. D. Cahill; Upper Cretaceous Foraminifera of the Gulf Coastal Plain, by J. A. Cushman and L. G. Henbest; the genus *Productus*, by G. H. Girty; ammonites of the Greenhorn limestone, by J. B. Reeside, jr.; the Ostracoda and Carboniferous microfossils, by P. V. Roundy; the early Paleozoic gastropods of

North America, by E. O. Ulrich and Josiah Bridge; early Paleozoic cephalopods, by E. O. Ulrich, Josiah Bridge, and A. F. Foerste; lower Paleozoic stratigraphy of the upper Mississippi Valley, by E. O. Ulrich; occurrence and major features of the supposed fossil plants from the pre-Cambrian formations of western America, by David White; geologic map of the United States, by G. W. Stose in cooperation with other members of the Geological Survey and with various State organizations; copper deposits of the southern Appalachian region, by C. S. Ross and M. N. Short; and geology of the Great Basin, by D. F. Hewett. Work was also done on an exhibit showing the rank of coals, by David White and M. R. Campbell, for the meeting of the committee on classification of coals.

The following papers giving results of general studies were completed or published during the year by the Geological Survey or in technical journals:

Alden, W. C., The great ice sheets of the Middle West. Prepared for presentation before the Chicago conference of the National Research Council.

Alden, W. C., Guidebook of Middle West glacial excursion of the Sixteenth International Geological Congress.

Matthes, F. E., Glacier measurements in the United States. Transactions of the Geophysical Union.

Bradley, W. H., Nonglacial marine varves. American Journal of Science.

Butts, Charles, The Appalachian Plateau and Mississippi Valley. Geologie der Erde.

Campbell, M. R., The alluvial fan of the Potomac River. Geological Society of America.

Knopf, E. B., Retrogressive metamorphism and phyllonitization. American Journal of Science.

Rubey, W. W., A plea for closer cooperation among students of stream work. Transactions of the Geophysical Union.

Rubey, W. W., Shortening of folded strata and scale structure sections. Science or American Journal of Science.

Mansfield, G. R., Some problems of the Rocky Mountain phosphate field. Economic Geology.

Hewett, D. F., Manganese reserves of the United States. Prepared for Committee on Industrial Preparedness of the American Institute of Mining and Metallurgical Engineers, to be submitted to the War Department.

Johnston, W. D., Jr., Chromium. Mineral Industry.

Richardson, G. B., New edition of map showing oil and gas fields and pipe lines in the United States.

Ross, C. S., and Kerr, P. F., The kaolin minerals. Professional Paper 165-E.

Ross, C. S., and Kerr, P. F., The clay minerals and their identity. Journal of Sedimentary Petrology.

Ross, C. S., Henderson, E. P., and Posnjak, E., Clarkeite; a new uranium mineral. American Mineralogist.

Short, M. N., Microscopic determination of the ore minerals. Bulletin 825.

WORK IN CHEMISTRY AND PHYSICS

The work in chemistry and physics includes tests and analyses of specimens and samples (other than waters) and researches on geochemical and geophysical problems.

During the year 8,412 examinations were made, of which 279 were complete quantitative analyses and 392 were qualitative analyses dealing with research problems other than potash, 1,265 were identifications of specimens sent in by persons not officially connected with the Geological Survey, 1,902 were qualitative tests for potash, 424 were quantitative determinations of potash, and 4,150 were petrographic or microscopic determinations of potash and associated minerals in cores and cuttings related to the search for potash.

W. T. Schaller identified many of the more difficult minerals collected by geologists in the field, attended meetings of the American Mineralogical Society, where he read papers on the chrysocolla group and ammonioborite, a new mineral, and studied in the field

the mineralogy of the mine of the United States Potash Co., near Carlsbad, N. Mex., on which a report is being prepared. Among the unusual minerals studied during the year were a manganese-calcium silicate from Oregon; the rare vanadium copper sulphide, sulvanite, from Utah; a manganoan cuprodescloizite from Arizona; the hydrated ferric sulphate, kornelite; and bavenite from California, a beryllium mineral. A cesium mica from the Black Hills was studied by J. J. Fahey, in collaboration with F. L. Hess.

Spectroscopic work occupied a large part of George Steiger's time. Spectra of known elements were prepared for reference, and a technique was developed by which about 50 tests for beryllium were made. Several unusual metallic associations in gold concentrates were also identified by the spectrograph.

Rock analyses were made principally by J. G. Fairchild, George Steiger, J. J. Fahey, L. T. Richardson, and E. T. Erickson. The substances analyzed ranged from diatomite to spinel, including gas from springs, gold and silver ores, beryl, mica, mine water, grahamite, niter, shale, clay, travertine, and volcanic ash.

R. C. Wells continued determinations of the age of minerals by the lead-uranium ratio and with L. T. Richardson studied the heat of solution of some potash minerals. He made a brief field trip to Colorado and New Mexico and another to Pennsylvania to examine an occurrence of uraninite in serpentine.

Investigations relating to the genesis of ores were carried on by R. E. Stevens, who measured the diffusion of gases through Swedish kolm and experimented on the behavior of certain silicates and metallic sulphides, especially pyrite, in various solutions in a bomb at 300° C. Chemical studies involving the geochemistry of organic substances were made by E. T. Erickson.

Potash investigations were continued mainly as described in the last few reports, with more emphasis on the field in Eddy County, N. Mex., where sylvite and carnallite have been found in sufficient richness to warrant sinking a shaft and mining in commercial quantities.

On account of the small force of chemists available analytical work was necessarily limited almost entirely to determinations of the potassium content of the richer portions of the cores and cuttings shipped from the field. The minerals were identified by petrographic methods, and their percentage also estimated approximately by this method when possible. The petrographic examinations were made principally by F. C. Calkins, with supplemental assistance by J. J. Fahey, L. T. Richardson, and W. T. Schaller. The chemical work on potash was done mainly by E. T. Erickson. R. K. Bailey continued at Roswell, N. Mex., preparing potash cores and well cuttings for shipment to Washington and making logs of wells. (See p. 13.)

Field measurements of deep earth temperatures were made by C. E. Van Orstrand during June, July, August, and September, 1930, in Alabama, Texas, Oklahoma, California, Oregon, Wyoming, and Michigan. Some of the observations were made in cooperation with the American Petroleum Institute. The results were computed with the assistance of H. C. Spicer, computer, who also began the

preparation of some mathematical tables of certain exponential functions.

P. G. Nutting continued his study of the activity of sands and clays in adsorbing oil, or certain components of oil, with particular reference to the seat of activity, its origin, its relation to the composition and structure of the material, and the nature of the adsorbed substance. He made many comparative tests of characteristic oil sands and filtering clays from both foreign and domestic sources.

During the winter a conference was held every two weeks at which members of the staff reviewed their work or summarized recent progress in geochemistry and geophysics.

The following papers were completed during the year:

- Schaller, W. T., Psittacinite from Arizona: *Am. Mineralogist*.
- The ending of modifiers of mineral names: *Am. Mineralogist*.
- Ammoniochlorite, a new mineral: *Am. Mineralogist*.
- Chemical composition of cuprotungstite: *Am. Mineralogist*.
- Ptilolite from Utah: *Am. Mineralogist*.
- Mordenite-ptilolite group: *Am. Mineralogist*.
- Tephroite crystal from New Jersey: *Am. Mineralogist*.
- Sulvanite from Utah: *Am. Mineralogist*.
- F. W. Clarke (memorial sketch): *Am. Mineralogist*.
- Schaller, W. T., and Nolan, T. B., Spadaite from Utah: *Am. Mineralogist*.
- Nutting, P. G., Chemical activation of quartz surfaces: *Science*.
- Physical analysis of oil sands: *Am. Assoc. Petroleum Geologists Bull.*
- Physical and chemical factors in the accumulation and discharge of oil: *Typical American oil fields*, vol. 3.
- Report on Temblor sands, prepared for conservation branch.
- Adsorption and base exchange: *Washington Acad. Sci. Jour.*
- Van Orstrand, C. E., Temperature gradients in the earth: *Symposium on oil field structure*, vol. 3.
- Fairchild, J. G., Note on determination of very small quantities of cadmium in a rich zinc ore: *Chemist-Analyst*.
- Wells, R. C., Evaporation as a function of insolation: *Am. Assoc. Civil Eng. Proc.*
- Book review: Tables for the determination of minerals, by Kraus and Hunt: *Ind. and Eng. Chemistry*.
- Scientific investigations relating to mineral deposits: *United States Daily*.
- Richardson, L. T., and Wells, R. C., The heat of solution of some potash minerals: *Washington Acad. Sci. Jour.*
- Erickson, E. T., The fatty class of plant and animal substances in sediments: *Am. Assoc. Petroleum Geologists Bull.*

ALASKAN BRANCH

PHILIP S. SMITH, Chief Alaskan Geologist

ORGANIZATION AND PERSONNEL

The Alaskan branch consisted at the end of the year of the chief Alaskan geologist, 4 geologists, 1 mining engineer, 1 coal-mining assistant, 4 topographic engineers, 1 draftsman, 4 clerks, and 1 minor apprentice lithographer. In addition, 9 geologists and 4 topographic engineers were employed for special service on the Alaska Railroad project, and numerous camp hands and other assistants were employed for temporary service.

SCOPE OF THE WORK

The task of obtaining information regarding the mineral resources of Alaska and assisting the industry in every practicable way has

for many years devolved upon the Alaskan branch. During the third of a century that this work has been in progress the Geological Survey has published many hundreds of reports on various phases of the mineral industry of Alaska, and these have been accompanied by several hundred maps of different parts of the territory. Practically every known mineral-producing camp has been visited by the geologists, engineers, and topographers of the Geological Survey, and reports regarding these camps have been issued.

The fiscal year has little significance in reporting on the Geological Survey's work in Alaska, especially because most of the appropriations for the Alaska work are made immediately available on the passage of the act through which the money is appropriated.

Two rather distinctly different kinds of technical work are performed by the Alaskan branch—one of a general investigational type and the other of a semiadministrative type in connection with the supervision of the leases granted by the Government covering coal, oil, and other mineral lands. Each is not only distinct in character but is supported by different funds. For convenience the two types of work will be referred to as the work on mineral resources and the leasing work.

FUNDS

The funds used by the Geological Survey in its Alaska work are provided in two items in the general act making appropriations for the Interior Department. One of these is "for continuation of the investigation of the mineral resources of Alaska." In the act for the fiscal year 1931 the amount appropriated was \$75,000. In the similar act for 1932 the amount appropriated was \$84,500. Each of these appropriations was made available immediately on the passage of the act in which it was contained. The other item is an allotment made from the appropriation "for the enforcement of the provisions of the acts of October 30, 1914, October 2, 1917, February 25, 1920, and March 4, 1921, and other acts relating to the mining and recovery of minerals on Indian and public lands and naval petroleum reserves." Allotments under this item are available only during the fiscal year specified. In the fiscal year 1931 an allotment of \$10,000 was made for work of this kind in Alaska.

WORK ON MINERAL RESOURCES

MANUSCRIPTS AND PUBLICATIONS

The principal products of the Alaska work of the Geological Survey are reports and maps based on original surveys or investigations. During the year six such official reports have been issued:

Notes on the geology of upper Nizina River, by F. H. Moffit (Bulletin 813-D).
Mineral resources of Alaska: Report on progress of investigations in 1928, by Philip S. Smith and others (Bulletin 813).

Geography and geology of northwestern Alaska, by Philip S. Smith and J. B. Mertie, jr. (Bulletin 815).

Mineral industry of Alaska in 1929, by Philip S. Smith (Bulletin 824-A).

Administrative report, 1929-30, by Philip S. Smith (Bulletin 824-A).

The Upper Cretaceous floras of Alaska, by Arthur Hollick, with a description of the Upper Cretaceous plant-bearing beds, by G. C. Martin (Professional Paper 159).

The following reports are in course of editing or printing:

The Slana district, upper Copper River region, by F. H. Moffit (Bulletin 824-B).

The Lake Clark-Mulchatna region, by S. R. Capps (Bulletin 824-C).

Mining in the Circle district, by J. B. Mertie, jr. (Bulletin 824-D).

The occurrence of gypsum at Iyoukeen Cove, Chichagof Island, by B. D. Stewart (Bulletin 824-E).

Glaciation in Alaska, by S. R. Capps (Professional Paper 170-A).

A geologic reconnaissance of the Dennison Fork district, by J. B. Mertie, jr. (Bulletin 827).

Eight reports have been completed by their authors and approved for publication:

Mineral industry of Alaska in 1930, by Philip S. Smith.

Administrative report, 1930-31, by Philip S. Smith.

The Kantishna district, by F. H. Moffit.

Mining developments in the Tatlanika and Totatlanika Basins, by F. H. Moffit.

The eastern portion of the Mount McKinley National Park, by S. R. Capps.

Geography and geology of Lituya Bay, by J. B. Mertie, jr.

The Tatonduk-Nation district, by J. B. Mertie, jr.

Surface water supply of southeastern Alaska, by F. F. Henshaw.

Seven short papers on the mineral production of Alaska and various phases of the work of the Alaskan branch were published as press memoranda.

Two maps were issued during the year, as follows:

Topographic map of Goodnews Bay district, by R. H. Sargent and W. S. Post; scale, 1:250,000. Issued in a preliminary photolithographic edition.

Topographic map of Valdez and vicinity, by J. W. Bagley, C. E. Giffin, and R. H. Sargent; scale, 1:62,500. Published for sale.

The following maps have been prepared and transmitted for publication during the year:

Topographic map of Revillagigedo Island, by R. H. Sargent; scale, 1:250,000. Compiled principally from aerial photographs taken by the Alaska Aerial Survey Expedition of the Navy Department, 1928 and 1929. To be issued in a preliminary photolithographic edition.

Topographic map of Mount Spurr region, by R. H. Sargent and Gerald Fitzgerald; scale, 1:250,000. To be published for sale.

Topographic map of Lake Clark-Mulchatna region, by Gerald Fitzgerald and R. H. Sargent; scale, 1:250,000. To be published for sale.

Alaska map E (reprint, extensively revised); scale, 1:2,500,000. To be published for sale.

Alaska map A (reprint, revised); scale, 1:5,000,000. To be published for sale.

Topographic map of lower Matanuska Valley (reprint, revised), by R. H. Sargent; scale, 1:62,500. To be published for sale.

In addition, practically all the published reports are accompanied by maps, the bases of which have been made principally from surveys conducted by the topographers of the Alaskan branch.

Progress was also made in the preparation of a map of the Nushagak region, scale 1:250,000, compiled from surveys made in 1930, and maps of portions of the Taku and Wrangell districts, compiled principally from aerial photographs taken by the Navy Department, for use as bases for topographic maps and for field studies.

Besides the official reports, several articles were prepared by the scientific and technical members of the Alaskan branch for publication in outside journals, and 41 public lectures were given regarding

the general work of the branch or some of its special features. Most of these were prepared unofficially but represent by-products of the regular work and serve to reach special audiences not readily reached by the official publications. Among the articles may be mentioned the following:

- Some popular misconceptions concerning Alaska, by Philip S. Smith.
- Geographic and geologic evidence relating to the connection of Siberia and northwestern Alaska, by Philip S. Smith.
- Random notes on recent ice as a geologic agent, by Philip S. Smith.
- Alaska and the Geological Survey, by Philip S. Smith.
- Photographing Alaska from 2 miles in the air, by R. H. Sargent.
- Paleozoic stratigraphy of the Upper Yukon, by J. B. Mertie, jr.
- Safety work in mines, by B. D. Stewart.

PROJECTS IN PROGRESS DURING THE SUMMER OF 1930

In addition to the routine duties of supplying information in answer to hundreds of inquiries received from the public and from other branches of the Government, 10 principal projects were carried on during the season of 1930, 7 involving field work and 3 only work in the office. The seven field projects are described below.

Topographic mapping in southeastern Alaska included the mapping of parts of Revillagigedo Island, on which Ketchikan is situated, and of the adjacent mainland, a project that was started during the field season of 1928. Much of this region contains indications of mineralization, and the maps will also serve as bases for other Government institutions and persons having to do with the development of the other resources of the region; for example, the Forest Service and others who are vitally interested in the power and pulp-wood resources.

In 1929 a rush of prospectors followed the announcement of the discovery of sulphide ores containing copper, zinc, lead, and gold in the Taku district, east of Juneau. Verification of the report that considerable tracts hitherto regarded as composed mainly of deep-seated igneous rocks and therefore unpromising as prospective mineral areas were really occupied by other rocks and might therefore repay prospecting, made it desirable that an authoritative statement based on a thorough field examination of the area should be prepared by the Geological Survey. B. D. Stewart, of the Juneau office, was assigned to the task and spent altogether about five weeks in the field, visiting as many of the prospects and as much of the area as time and other conditions permitted.

For many years it has been realized that the success of the Government-owned railroad in Alaska would depend in no small measure on the development of the mineral resources along its route. The general manager, Col. O. F. Ohlson, asked for some assistance by the Geological Survey in aiding this development, and in 1930 two geologic parties were assigned to the railroad zone. These parties were in charge of F. H. Moffit and S. R. Capps. The special areas studied by Mr. Moffit were the Kantishna district and near-by country west of the railroad and part of the Bonfield district east of the railroad. The party in charge of Mr. Capps examined the geology and mineral resources of a tract on the south side of the Alaska Range extending eastward from the head of the West Fork of the Chulitna River to the Nenana River. Parts of this area were known to be mineralized, and in addition its survey was undertaken to permit the construction of a complete section across the range and thus contribute to the interpretation of the geologic events that have occurred and throw light on their relation to the occurrence of ore deposits. An area of about 300 square miles was surveyed geologically on reconnaissance standards and about 180 square miles that had been surveyed in earlier years was more intensively studied and its geology thoroughly revised, so as to bring it into adjustment with the latest information on the region as a whole.

One of the largest unsurveyed tracts still remaining in Alaska lies in southwestern Alaska north of Bristol Bay. Reports received from prospectors and indications that were seen in the nearest areas that had been examined

by the Geological Survey gave reason to believe that in parts of this tract there might be valuable mineral deposits, and in order that more authoritative information might be available a start was made on the work of surveying the tract by a party in charge of Gerald FitzGerald. Field work began June 5 and ended September 8. During that period an area of 2,400 square miles was surveyed topographically for publication on a scale of 4 miles to 1 inch, with a contour interval of 200 feet. In the course of the work about 125 miles of river traverse was made on a field scale of 1:98,000 (1½ miles to 1 inch), using micrometer and rod readings, with a contour interval of 100 feet.

Another large area in Alaska that has long remained unsurveyed and little visited even by casual trappers is the triangular tract lying between the Yukon and Porcupine Rivers west of the international boundary. Reconnaissance geologic surveys of this tract were made in 1930 by a party in charge of J. B. Mertie, jr. No topographic map was available to show even the major features of the country or to serve as a base on which to plat the geologic observations, but a drainage map of the southeastern part of the area was prepared as one of the results of the traverses and plane-table sketches of the geologist. Field work began on the Yukon at the mouth of the Tatonduk River June 5 and ended September 2. The drainage and geologic features of an area of 500 square miles were mapped adequately for publication on the usual reconnaissance scale.

The customary broad survey of recent developments in the mining industry as a whole, with special visits to some of the more active mining camps or those that had not been recently visited by members of the Geological Survey, was made by Phillip S. Smith, chief Alaskan geologist. Leaving Washington late in June, he spent some time with the topographic party of Mr. Sargent in southeastern Alaska. In Juneau he held brief consultations with B. D. Stewart, of the Geological Survey office, and with officials of other bureaus whose work bears close relations to that of the Geological Survey. Mr. Smith then went to Anchorage for consultation with Colonel Ohlson regarding the mineral investigations for the Alaska Railroad and made personal studies in all the productive mining camps adjacent to the railroad between Seward and the Willow Creek gold lode district. In August, under instructions from Washington, Mr. Smith joined the special senatorial investigating committee under the chairmanship of Senator Howell and remained with that committee throughout its study in the railroad belt, in order to make available any information regarding mineral resources it might call for.

The areas reported in the following table are based on the field season and not on the fiscal year, and therefore no account is taken of the work that was started during the field season of 1931 but remained uncompleted at the end of the fiscal year 1931.

Areas surveyed by Geological Survey in Alaska, 1898-1930, in square miles

Field season	Geologic surveys			Topographic surveys		
	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)
1898-1929.....	75, 180	176, 330	4, 277	55, 630	209, 905	4, 066
1930.....	500	480			3, 344	
	75, 680	176, 630	4, 277	55, 630	213, 249	4, 066
Percentage surveyed of total area of Alaska.....	43. 7			46. 5		

* Includes 180 square miles revised extensively in 1930, included also under 1930, and therefore counted only once in the total.

In this table only the net areas surveyed are listed in the appropriate column, though of course most of the areas that have been surveyed geologically have also been surveyed topographically. It

is by no means unusual that areas surveyed hastily at first are later resurveyed with more precision on the same or larger scale, and if the areas thus revised were not excluded from the totals the same areas would be counted twice.

The scale most commonly adopted for Alaska surveys, either geologic or topographic, is the reconnaissance scale (1:250,000), about 4 miles to the inch, with a contour interval of 200 feet. This scale is adequate for most general purposes, and the maps can be made expeditiously and cheaply. For work requiring less detailed mapping the exploratory scale of 8 to 10 miles to the inch has been adopted. For detailed work the usual scale is 1 mile to the inch, but larger scales are used if required. Thus, the surveys of the region near the mines at Juneau were on a scale of about one-third mile to the inch.

The office project of compiling for map use the aerial photographs made by the Navy Department in southeastern Alaska was continued throughout the fiscal year. At the present rate of progress it will be more than a decade before even the material that is now on hand can be worked up. During 1930 drainage maps were compiled for areas of about 400 square miles in the Taku district near Juneau and of between 500 and 600 square miles in the region between Wrangell and the earlier mapped area north of Ketchikan. This work was in charge of R. H. Sargent, who devoted much of his own time to it and was assisted by V. S. Seward, topographic engineer, and J. I. Davidson, draftsman.

The collection of information regarding the output of minerals from Alaska each year is carried on mainly from the Washington office, but the wide acquaintance of the field men and their surveys in different parts of the Territory make them a source of much definite information. In addition, many of the other Government organizations collect data within their respective fields which contribute to the general result. Banks, express companies, and other organizations conducting business in Alaska also assist.

The Geological Survey maintains in Alaska two district offices, one at Juneau and one at Anchorage. The main duties of the personnel attached to these offices relate to mineral leasing, but a part of their service relates to general investigations of mineral resources. Under this arrangement approximately two-fifths of the time of B. D. Stewart, who supervises the local offices, is allotted to general investigations of mineral resources. The Alaska offices also act as local distributing points for publications of the Geological Survey and assist in furnishing the main office at Washington with information on many phases of the mineral industry of the Territory.

PROJECTS FOR THE SEASON OF 1931

Eleven projects, funds for which were appropriated directly to the Geological Survey, have been approved for the season of 1931. These projects had been under way for only a short time at the end of the fiscal year, and no specific details are available regarding the work accomplished. Eight of these projects that involve field work are reconnaissance topographic mapping in the Wrangell-Ketchikan district, southeastern Alaska; mining studies principally in the Taku district near Juneau and at other points in southeastern

Alaska; geologic investigations in the vicinity of Glacier Bay; reconnaissance topographic mapping in the Klutina Lake district, in the Copper River Valley; reconnaissance geologic studies in the Alaska Range at the head of the Copper River; geologic and topographic reconnaissance surveys in the Tikchik Lakes district of southwestern Alaska; geologic reconnaissance of parts of the Yukon-Tanana Region, central Alaska; and general studies of the mining developments throughout Alaska.

The topographic mapping in the Wrangell-Ketchikan district is a continuation of the work that was started in the Ketchikan district in 1928 and continued in 1930, whereby an area of about 1,900 square miles was mapped. The work done in 1931 will tie to this earlier work and carry it northward as far as time and other conditions permit.

The Taku project is a continuation of the investigations that were started in 1930. B. D. Stewart will again be in charge of this work.

Several years ago field investigations of the region adjacent to Glacier Bay, west of Juneau, were carried on by F. E. and C. W. Wright, but the results were not completed in form for publication. Through cooperation with the Bureau of Mines the services of C. W. Wright, who is now a member of that bureau, have been made available for the completion of this project.

Lying west of the Richardson Highway in that part of its course between Tonsina and Copper Center, in the Copper River Valley, and including Klutina and Tonsina Lakes, is a tract of country that was not surveyed during the time that the country near it to the north and to the east was mapped. As a preliminary to geologic studies in this area a topographic party in charge of C. F. Fuechsel was sent into the region early in June.

A start on the geologic examination of that part of the Alaska Range which lies between the head of the Copper River and Tanana Valley, east of the Delta River and extending as far as the international boundary, was made in 1929 by a small exploratory party in charge of F. H. Moffit. In 1931 Mr. Moffit has resumed his general studies in this region, though without aid of a suitable topographic map. Work started early in June and will continue into September.

In southwestern Alaska a combined topographic and geologic party in charge of Gerald FitzGerald, topographer, with P. A. Davison, geologist, will carry forward the work started by Mr. FitzGerald in 1930, of mapping as much as practicable of the unsurveyed area lying between Bristol Bay and the headwaters of the Holitna and other streams near it that are tributary to the Kuskokwim River.

Ever since the earliest investigations of Alaska's mineral resources by the Geological Survey its parties have traversed parts of the great belt of country lying between the Yukon and Tanana Rivers. Work in this area has reached an advanced stage, but before it can be completed certain problems require further field examination. To do this work J. B. Mertie, Jr., with a small party, landed at Rampart early in June. During the summer he will visit parts of the Rampart and Hot Springs districts and, if time and other conditions permit, will swing eastward into the Livengood or Tolovana district, perhaps ending his season at Fairbanks about the middle of September.

The general survey of Alaska mining conditions to be conducted by the chief Alaskan geologist during the season of 1931 will resemble similar work in the past, but owing to duties in Washington the actual field work will not be started until after the first of July.

The office compilation of drainage maps from the thousands of photographs taken by the Navy aviators in southeastern Alaska is being continued. It is essential that drainage maps of this sort covering at least 2,000 square miles should be compiled before the field season of 1932 begins, as otherwise the topographic mapping will have to be delayed. Even without topography these maps are in much demand by the Forest Service and other Government organizations and private individuals who are active in developing southeastern Alaska.

RAILROAD PROJECT

The most extensive project undertaken by the Geological Survey in Alaska in 1931 is not supported by funds appropriated to it directly, but by funds that have been transferred for its use by the Alaska Railroad. The item for the Alaska Railroad in the Interior Department appropriation act for 1931 includes a provision "that not to exceed \$250,000 of this fund shall be available for continuation of the investigation of mineral and other resources of Alaska to ascertain the potential resources available which will affect railroad tonnage." Arrangements have been made whereby the Geological Survey is to conduct such of these investigations as pertain to mineral resources in the interests of the railroad and in such manner and at such places as are approved by the responsible railroad officials. Plans were drawn up by the Geological Survey and approved by the manager of the railroad, and the funds necessary to start the work were supplied for examinations in the Anthracite Ridge, Copper Mountain, Kantishna, Valdez Creek-Chulitna, Fairbanks, Willow Creek, Girdwood, and Moose Pass areas. The plans also include an examination of the nonmetallic mineral resources throughout the railroad belt and the maintenance of a geologist throughout the year to serve as general representative to advise the manager on mining and geologic matters, to work with prospectors and make available the results of the surveys, and to serve as a medium of coordination between the railroad and other agencies engaged in this program.

Work on all these projects is in general charge of S. R. Capps, who started the field work early in June and will keep it going as late in the fall as practicable. From the later part of July to the end of the work Mr. Capps will be assisted in his general supervision by D. F. Hewett, geologist. Through the courtesy of the Bureau of Mines the samples collected in the course of the work will be analyzed at the laboratories of the bureau in Alaska—the coal samples in the coal-testing laboratory at Anchorage and the metallic and nonmetallic minerals other than coal in the laboratory at Fairbanks conducted in cooperation with the Alaska Agricultural College and School of Mines.

In the Anthracite Ridge region are deposits of coal, some of which are of anthracite quality. The region is intersected by many faults, and the beds are cut by or interlaminated with many igneous intrusives. Only by very detailed work can the amount of coal be determined. It is therefore proposed that mapping, both geologic and topographic, on a scale of 5 inches to the mile will be undertaken. This project is in charge of Ralph W. Richards, geologist, and the topographic work will be done by L. O. Newsome. About 20 men will be needed for various phases of the work on this project.

In the Kantishna and Copper Mountain districts, which lie 60 miles or more west of the Alaska Railroad and north of the Alaska Range, silver-lead, zinc, copper, antimony, and gold lodes have long been known and ore has been shipped from some of the lodes, though, because of the remoteness of the region, it has not well repaid the operators in spite of the fact that some of it had a value of over \$100 a ton. No detailed maps of either of these tracts are available, so a separate topographic party has been assigned to each to make a map of the mineralized area on a scale of 1 mile to the inch. S. N. Stoner, topographer, is in charge of the party at Copper Mountain and S. C. Kain of the topographic work in the Kantishna district. Investigations of the geology and ore deposits will also be made—in the Kantishna district by F. G. Wells, who will act as chief of the combined geologic and topographic party, and at Copper Mountain by J. C. Reed, who will conduct the geologic work.

The Valdez Creek district lies about 50 miles due east of Cantwell, a station on the Alaska Railroad not far from Broad Pass. Gold lodes occur in this district but have been only slightly developed. To assist in the determination of the extent and character of the mineralization a small geologic party in charge of C. P. Ross will carry on reconnaissance surveys.

In the Willow Creek and Fairbanks districts gold lodes are being productively mined, and in the past the ores from each have yielded gold worth more than a million dollars. The mines are all small, and the efforts of the operators are necessarily directed toward finding and developing small, rich veins which do not afford tonnage of significance to the railroad. The Geological Survey's studies in these districts will, therefore, be directed largely toward determining the volume of low-grade ores that might be profitably developed if worked on a large scale. This work in the Fairbanks district will be carried on by J. M. Hill and in the Willow Creek district by J. C. Ray.

North of Turnagain Arm and about 40 miles east of Anchorage, in the neighborhood of Girdwood, gold placers have been worked for many years, and in the hills at the head of the valleys in which they occur, notably at the head of Crow Creek, rich gold ores have been found and some underground development work done. This region has not been surveyed in detail, and only the larger aspects of its geology have been determined. In this area a combined topographic and geologic party in charge of W. G. Carson, topographer, with C. F. Park, geologist, will map on a scale of 1 mile to the inch as much of the country as time and other conditions permit.

Extending for nearly the whole length of Kenai Peninsula southward from Turnagain Arm is a series of black slates and shales which in many places are cut by intrusive igneous rocks and intersected by quartz veins and stringers, the whole more or less mineralized. Many small prospects and small productive mines have been opened within this belt, and more detailed study of it than heretofore will be made by the party in charge of Ralph Tuck.

EXPENDITURES

The funds directly appropriated for the work of the Geological Survey on Alaska's mineral resources during the field season of 1930 were made available through the Interior Department appropriation acts for 1930 and 1931. Each act made the funds appropriated available immediately. The act for 1930 was approved March 4, 1929, and the act for 1931 was approved May 14, 1930. The amount appropriated by the act for 1930 was \$67,500; for 1931, \$75,000. During the field season of 1931 the funds used were made available through the act for 1931, already noted, and the act for 1932, which appropriated \$84,500.

In April, 1931, in order to finance the work which the Geological Survey was requested to perform in the interests of the Alaska Railroad, transfers of \$30,000 for direct expenditures by the Geological Survey were made by the railroad. These funds were considered available for expenditure by the Geological Survey only up to the end of the fiscal year, but a supplementary transfer of \$50,500 to continue the work until about the end of the calendar year 1931 was made, and further transfers will be requested as additional funds are required.

Expenditures from funds appropriated for investigation of mineral resources of Alaska for the fiscal year 1930-31

Projects for the season of 1930.....	\$12, 939
Projects for the season of 1931.....	17, 690
Administrative salaries, July 1, 1930, to June 30, 1931.....	3, 173
All other technical and professional salaries, July 1, 1930, to June 30, 1931.....	29, 766
All other clerical and drafting salaries, July 1, 1930, to June 30, 1931.....	8, 307
Office maintenance and expenses.....	3, 125

75,000

Of the \$30,629 allotted to field projects for both seasons, about 53 per cent was allotted to geologic or related general work and 47 per cent to topographic work.

The item for administrative salaries includes only those salaries that are directly related to general administration and does not include charges for administration such as each party chief is called on to perform with regard to the party in his charge. The low cost of administration is due principally to the fact that the administrative officers are engaged also in technical projects, to which is therefore charged a proportional part of their salaries.

LEASING WORK

Part of the activities of the Alaskan branch are related to the proper conduct of mining work on the public mineral lands that have been or may be leased to private individuals or corporations under certain laws. Funds for this work throughout the United States are provided in a general item contained in the Interior Department appropriation act. The amount allotted to Alaska for the fiscal year 1931 was \$10,000.

In order that the policies and practices that have been developed by the leasing unit of the conservation branch of the Geological Survey for handling the much larger volume of similar work in the States should be maintained in Alaska and at the same time the specialized knowledge of Alaskan affairs possessed by the Alaskan branch should be utilized, the general conduct of the leasing work in Alaska is in a measure shared between the two branches, the office work in Washington being done principally by the conservation branch and the field work by the Alaskan branch. B. D. Stewart, supervising engineer, who has headquarters at Juneau, is in immediate charge of the field work, assisted by J. J. Corey, coal-mining engineer, at Anchorage.

The primary purpose of the leasing work is to supervise the operations under the coal and oil leases or permits that have been granted by the Government and to advise and consult with the proper authorities, both Federal officers and private applicants, regarding lands that may be under consideration for a lease or permit. Practically all the coal mining and much of the oil prospecting in Alaska is done on public lands by private individuals or companies under leases or permits issued by the Secretary of the Interior. The interest of the Government in these lands requires not only that these grants shall be a source of revenue to the Nation but that proper methods of extracting the minerals shall be employed, thus preventing waste or damage to the property, and that the lives, health, and welfare of those engaged in the work shall be properly safeguarded. Practically all the producing coal mines that have been opened in the Territory are in the region adjacent to the Alaska Railroad. The Government has therefore an especial interest in their successful operation. For this reason the Federal engineers have given intensive study to the problems confronting these mines and have been especially active in supervising their operations, not only to see that the terms of the leases are observed but also to be of as much assistance as possible to the small operators who are opening them, by giving them competent technical advice and aiding them in making their ventures successful.

TOPOGRAPHIC BRANCH

J. G. STAACK, Chief Topographic Engineer

ORGANIZATION AND PERSONNEL

At the end of the year the organization of the topographic branch was as follows:

Atlantic division, Albert Pike, division engineer, in charge.
 Central division, Glenn S. Smith, division engineer, in charge.
 Pacific division, H. H. Hodgeson, division engineer, in charge.
 Section of inspection and editing, W. M. Beaman, topographic engineer, in charge.
 Section of computing, S. S. Gannett, topographic engineer, in charge.
 Section of photographic mapping, J. H. Wheat, topographic engineer, in charge.
 Section of cartography, A. F. Hassan, cartographic engineer, in charge.
 Map information office, J. H. Wheat, topographic engineer, in charge.

Including the above-named engineers, the technical force comprises 173 topographic, geodetic, or cartographic engineers of various grades and 68 engineering field aides and draftsmen of various grades—a total of 241. The clerical force comprises 16 clerks.

EXPENDITURES

As shown in the table which follows, the Geological Survey supplements to a notable extent its own appropriations for topographic mapping with State and other Federal funds for similar purposes. Under this policy of cooperation the topographic work is standardized and its cost reduced. The total expenditures for topographic mapping were \$1,342,181.14.

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1931

	Appropriation for topographic surveys	Transfers and repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Topographic surveys, 1931.....	\$744,000.00	\$256,559.98	\$1,000,559.98	\$428,781.88	\$1,429,341.86
Great Smoky National Park, 1929-30.....	7,020.10	-----	7,020.10	-----	7,020.10
Great Smoky National Park, 1930-31.....	50,000.00	-----	50,000.00	-----	50,000.00
Shenandoah National Park, 1930-31.....	25,000.00	-----	25,000.00	-----	25,000.00
Mammoth Cave National Park, 1930-31.....	25,000.00	-----	25,000.00	-----	25,000.00
Mammoth Cave National Park (second deficiency, 1931).....	4,600.00	-----	4,600.00	-----	4,600.00
Total appropriations.....	855,620.10	256,559.98	1,112,180.08	428,781.88	1,540,961.96
Second deficiency bill, 1931, reappropriations from topographic survey funds.....	84,600.00	-----	84,600.00	-----	84,600.00
Total funds available.....	771,020.10	256,559.98	1,027,580.08	428,781.88	1,456,361.96
Expenditures:					
Alabama.....	13,004.60	-----	13,004.60	10,000.00	23,004.60
Arizona.....	16,803.84	-----	16,803.84	-----	16,803.84
Arkansas.....	10,295.47	-----	10,295.47	-----	10,295.47
California.....	61,718.27	2,865.49	64,583.76	60,658.51	125,242.27
Colorado.....	18,843.67	-----	18,843.67	11,287.23	30,080.90
Florida.....	-----	13,304.72	13,304.72	-----	13,304.72
Georgia.....	-----	34,945.05	34,945.05	-----	34,945.05
Hawaii.....	10,850.02	-----	10,850.02	4,995.32	15,845.34
Idaho.....	19,481.19	-----	19,481.19	2,528.87	22,010.06
Illinois.....	17,877.28	-----	17,877.28	47,786.27	65,663.55
Iowa.....	1,361.59	-----	1,361.59	2,028.82	3,390.41

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1931—Continued

	Appropriation for topographic surveys	Transfers and repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Expenditures—Continued.					
Kentucky.....	\$29, 168. 87		\$29, 168. 87		\$29, 168. 87
Louisiana.....		\$10, 943. 81	10, 943. 81		10, 943. 81
Maine.....	48, 543. 50	21, 680. 51	70, 224. 01	\$56, 119. 00	126, 343. 01
Michigan.....	23, 031. 50		23, 031. 50	37, 014. 11	60, 045. 61
Mississippi.....	232. 35	63, 822. 04	63, 554. 39		63, 554. 39
Missouri.....	21, 295. 94	46, 906. 21	68, 202. 15	22, 164. 35	90, 366. 50
Montana.....	15, 675. 86		15, 675. 86	2, 100. 18	17, 776. 04
Nevada.....	7, 285. 58		7, 285. 58		7, 285. 58
New Hampshire.....	19, 505. 67		19, 505. 67	13, 026. 75	32, 532. 42
New Mexico.....	6, 779. 35		6, 779. 35	3, 262. 52	10, 071. 67
New York.....	8, 637. 96		8, 637. 96	20, 251. 22	28, 889. 18
North Carolina.....	29, 758. 66		29, 758. 66		29, 758. 66
North Dakota.....	705. 36	2, 136. 86	2, 842. 22		2, 842. 22
Oklahoma.....		1, 552. 21	1, 552. 21	1, 589. 17	3, 121. 38
Oregon.....	28, 041. 77	7, 812. 18	35, 853. 95	7, 947. 46	43, 801. 41
Pennsylvania.....	25, 406. 17	2, 174. 84	27, 581. 01	25, 107. 50	52, 688. 51
South Dakota.....		2, 539. 59	2, 539. 59		2, 539. 59
Tennessee.....	42, 468. 27		42, 458. 27	13, 000. 00	55, 468. 27
Texas.....	13, 931. 02		13, 931. 02	27, 667. 59	41, 598. 61
Utah.....	10, 483. 29		10, 483. 29		10, 483. 29
Vermont.....	1, 591. 83		1, 591. 83	4, 999. 91	6, 591. 74
Virginia.....	64, 805. 15	15, 910. 32	80, 715. 47	34, 000. 00	114, 715. 47
Washington.....	22, 628. 40	18, 388. 43	41, 016. 83	3, 479. 04	44, 495. 87
West Virginia.....	1, 985. 20		1, 985. 20	2, 997. 16	4, 982. 36
Wisconsin.....	13, 608. 08	5, 560. 20	19, 168. 28	14, 810. 90	33, 979. 18
Wyoming.....	7, 178. 66		7, 178. 66		7, 178. 66
Division contingents.....	6, 535. 28		6, 535. 28		6, 535. 28
Field distribution offices.....	1, 100. 00		1, 100. 00		1, 100. 00
Books for library.....	215. 92		215. 92		215. 92
Map information.....	3, 565. 54		3, 565. 54		3, 565. 54
One-millionth maps.....	10, 010. 82		10, 010. 82		10, 010. 82
Stationery (field).....	850. 00		850. 00		850. 00
Computing.....	3, 056. 93		3, 056. 93		3, 056. 93
Inspection and editing.....	6, 462. 93		6, 462. 93		6, 462. 93
Office salaries.....	4, 529. 35		4, 529. 35		4, 529. 35
Photographic mapping.....	1, 653. 10		1, 653. 10		1, 653. 10
Instruments (field).....	5, 053. 09		5, 053. 09		5, 053. 09
Chief topographic engineer contingent.....	1, 319. 95		1, 319. 95		1, 319. 95
Miscellaneous repay.....		2, 924. 66	2, 924. 66		2, 924. 66
Refunds and adjustments.....		4, 093. 36	4, 093. 36		4, 093. 36
Total expenditures.....	\$656, 839. 28	256, 559. 98	913, 399. 26	428, 781. 88	1, 342, 181. 14
Unexpended balance.....	\$114, 180. 82		114, 180. 82		114, 180. 82
Grand total.....	771, 020. 10	256, 559. 98	1, 027, 580. 08	428, 781. 88	1, 456, 361. 96

* Represents 29.06 per cent of total cost; balance included in charges for State cooperation and Federal field projects.

* \$350,672.08 expended on State cooperation.

* Includes \$674.27 Mammoth Cave National Park and \$2,768.17 Shenandoah National Park balances.

GENERAL OFFICE WORK

Necessary office work incidental to the field work consisted in the inking, inspection, and editing of the topographic field sheets prior to their submission for reproduction, the computation and adjustment of the results of control field work, and the preparation of partial culture and drainage bases from aerial photographs. Base maps of Georgia and Michigan were begun, and a contour map of Colorado was completed. Railroad maps were prepared for the Congressional Record, world maps for the Department of State, and an eclipse map for the Nautical Almanac. Office mapping from aerial photographs was completed for the upper Columbia River,

Washington, and was begun for the Zion National Park, Utah. Stereophotogrammetry, or the measurement of horizontal distances and elevations from photographic plates by means of an optical measuring and drafting apparatus, was employed on both projects. Aerial photographs for use in topographic mapping were furnished by the Air Corps, United States Army, under a continued cooperative agreement which had been found satisfactory and economical. Contracts for aerial photographic work were also awarded to commercial firms when the exigencies of the mapping warranted it. The increasing use of aerial photographs attests to the value of this new adjunct to topographic mapping. (See also p. 84, Inspection and editing of topographic maps.)

SUMMARY OF RESULTS

The status of topographic surveys is set forth by States in the following table, which shows that the country as a whole is now 44.6 per cent mapped, the year's increment amounting to four-tenths of 1 per cent. There was a large increase in the number of surveys requested by other departments and bureaus, as compared with former years. The resurveys in large part covered areas previously surveyed on a smaller scale.

FIELD SURVEYS

Alabama.—The State geologist of Alabama cooperating, the survey of the Cottondale quadrangle was completed and that of the Blocton quadrangle was continued.

Arizona.—At the request of the geologic branch the survey of the Ajo quadrangle was begun. The survey of the Camp Verde quadrangle for the Forest Service was begun. The cultural revision for the west half of the Moon Mountain quadrangle was completed.

California.—In cooperation with the State engineer of California the survey of the Stevens, Lokern, Discovery Well, Canoas Creek, Kettleman Plain, Middle Dome, Avenal Gap, County Mill, Coal Oil Canyon, Pentland Junction, No. 71, No. 72, and No. 73 quadrangles was completed, and that of the Tejon Hills and No. 39 quadrangles was begun. In cooperation with the county surveyor of Los Angeles County, the survey of the Wilsona, Lovejoy Springs, Little Rock, Casa Desierta, Joshua, Del Sur, Moody Springs, Llano, Ravenna, Esperanza School, Little Buttes, No. 1, No. 2, No. 3, and No. 6 quadrangles was completed, that of the Del Valle quadrangle was continued, and that of the Red Rover, Red Mountain, Redrock Mountain, Warm Spring Canyon, Whitaker Peak, Oak Flat, and Beartrap Canyon quadrangles was begun. At the request of the Forest Service the survey of the Hoaglin quadrangle was continued. In preparation for geologic mapping the survey of the White River No. 3 quadrangle was begun. At the request of the Federal Power Commission the survey of the Tehipite Valley, Kellers Ranch, Oat Mountain, and Cedar Grove reservoir and dam sites on Kings River was completed.

Colorado.—In cooperation with the Colorado Metal Mining Fund and the Colorado Geological Survey Board, the survey of the Lost Creek drainage basin, Rico district, Kokomo-Robinson area, Nederland and vicinity, and Ironton and vicinity was completed, and that of the Ouray mining district was continued. For the Forest Service the survey of the Mount Powell No. 3 quadrangle was completed.

Florida.—The survey of the Pensacola Naval Air Station was completed for the Navy Department.

Georgia.—The survey of the upper Altamaha River Basin, covering parts of the Oconee, Apalachee, Ocmulgee, Alcovy, South, and Yellow Rivers, with tributaries, was completed in cooperation with the United States Army district engineer at Savannah.

Hawaii.—In cooperation with the commissioner of public lands of the Territory of Hawaii the cultural revision was completed for the Hilo quadrangle.

Idaho.—The Bureau of Mines and Geology cooperating, the survey of the Little Eightmile mining district was completed. The survey of the Newsome quadrangle was continued at the request of the Forest Service. For the National Park Service the survey of an addition to the Craters of the Moon National Monument was completed. In preparation for geologic mapping, the survey of the Irwin quadrangle was begun. The survey of the Callispell quadrangle was begun.

Illinois.—The survey of the Jerseyville, Fithian, Granite City, and Monks Mound quadrangles and highway projects Nos. 91 (Maquon and Galva quadrangles), 93 (Toulon quadrangle), 104 (Jacksonville quadrangle), and 119 (Arrowsmith, LeRoy, McLean, and Minier quadrangles), was completed, that of the Metamora and Dunlap quadrangles was continued, and that of the Orion, Pecatonica, and Potomac quadrangles and highway project No. 82 (Prophetstown quadrangle) was begun. This work was done in cooperation with the Department of Registration and Education of Illinois, Geological Survey.

Iowa.—The State geologist of Iowa cooperating, the survey of the Iowa City quadrangle was begun.

Kentucky.—The survey of the proposed Mammoth Cave National Park was completed.

Maine.—In cooperation with the Public Utilities Commission of Maine the survey of the Pittsfield, Forks of Machias, Tunk Lake, Allagash, Strong, Milan, and Errol quadrangles was completed, that of the Saponac and Ashland quadrangles was continued, and that of the Fish River Lake, Boyd Lake, Sysladobsis Lake, Stetson, Nicasious Lake, Presque Isle, Bridgewater Center, and Mooseleuk Mountain quadrangles was begun. In cooperation with the War Department the survey of the Fort Fairfield, St. Francis, and Vanceboro

quadrangles was completed and that of the Forest, Van Buren, and Johns Pond quadrangles was begun.

Michigan.—In cooperation with the Department of Conservation of Michigan, Geological Survey, the survey of the Muskegon, Shepherd, and Lake Harbor quadrangles was completed and that of the Cement City quadrangle was begun, and the compilation from aerial photographs of the culture and drainage of Isle Royal, Mackinac, and Bois Blanc Islands was completed and that of the Groscap, St. Ignace, Hart, Walkerville, Fern, Cooke, Baldwin, Ludington, Manistee, Freesoil, and Hiawatha quadrangles was begun.

Mississippi.—In cooperation with the United States Army district engineer at Memphis, Tenn., the survey of the Horn Lake, Strayhorn, and Rich quadrangles was begun, and in cooperation with the United States Army district engineer at Vicksburg the survey of the Whaley, Cypress Brake, Sumner, Doddsville, Tippto, and Mound Bayou quadrangles was begun.

Missouri.—The survey of the De Soto No. 1, De Soto No. 4, and Jefferson City No. 4 quadrangles was begun in cooperation with the State geologist of Missouri. In cooperation with the United States Army district engineer at Memphis, Tenn., the survey of the Sikeston, Bloomfield, Thebes, and Cairo quadrangles was completed and that of the Hendrickson, Morley, Advance, Puxico, and Greenbrier quadrangles was begun. In cooperation with the Department of Justice the survey of a proposed site for a hospital near Springfield was completed.

Montana.—The survey of the Libby quadrangle was completed for geologic mapping. For the Forest Service the survey of the Trout Creek quadrangle was begun.

Nevada.—The survey of the Halleck quadrangle for the Forest Service was begun.

New Hampshire.—In cooperation with the Highway Department of New Hampshire the survey of the Dixville, Percy, Milan, Errol, and Barnet quadrangles was completed and that of the Woodsville, Groton, and Lowell quadrangles was begun.

New Mexico.—The survey of the Central District area and Virginia mining district was completed in cooperation with the Bureau of Mines and Mineral Resources of New Mexico.

New York.—The survey of the Kinderhook and Schunemunk quadrangles was completed, that of the Ramapo quadrangle was continued, and that of the Rochester No. 1, Catskill, and Rhinebeck quadrangles was begun in cooperation with the Department of Public Works of New York. In cooperation with Monroe County and the Department of Public Works of New York the survey of the Braddock Point No. 3 quadrangle was completed and that of the Rochester No. 2, Rochester No. 3, and Rochester No. 4 quadrangles was begun.

North Carolina.—The survey of the North Carolina portion of the Great Smoky Mountains National Park was continued.

North Dakota.—The survey of the Fort Totten Indian Agency in North Dakota was completed for the Indian Service.

Oklahoma.—In cooperation with the Department of Justice the survey of the proposed location of the Southwestern Reformatory, near El Reno, was completed.

Oregon.—The survey of The Dalles and Dufur quadrangles was completed and that of the Pendleton quadrangle was continued in cooperation with the State engineer of Oregon. For the Forest Service the survey of the Malden Peak quadrangle was completed. In preparation for geologic mapping the survey of the Dayville quadrangle was begun.

Oregon-Washington.—The survey of the lower Columbia River between Vancouver, Wash., and Mayger, Oreg., was completed in cooperation with the United States Army district engineer at Portland, Oreg.

Pennsylvania.—In cooperation with the Department of Internal Affairs of Pennsylvania, Topographic and Geologic Survey, the survey of the Loysville, Warrensville, and Starrucca quadrangles was completed, that of the Millville and Laporte quadrangles was begun, and the cultural revision of the Connells-ville quadrangle was begun. In cooperation with the Department of Justice the survey of a prison site near Lewisburg was completed. The revision of the Eagles Mere quadrangle was completed.

South Dakota.—The survey of the Rosebud Indian Agency and the Pine Ridge Indian Agency in South Dakota was completed for the Indian Service.

Tennessee.—With the cooperation of the State geologist of Tennessee the survey of the Pegram and Ridgetop quadrangles was completed. The survey

of the Tennessee portion of the Great Smoky Mountains National Park was continued.

Texas.—With the cooperation of the Board of Water Engineers of Texas the survey of the Burnet No. 4, Blanco No. 1, Austin No. 2, and Marble Falls quadrangles was completed. In cooperation with the Reclamation Department of Texas the survey of the Harlem-Imperial Farms and Darrington-Ramsey Farms projects was completed.

Utah.—The survey of the Zion National Park for the National Park Service was continued.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Saxtons River quadrangle was completed and that of the Mount Cube quadrangle was begun.

Virginia.—The survey of the Independence, Old Town, Wakefield, Stanardsville, and Warm Springs Run quadrangles was completed, that of the Healing Springs quadrangle was continued, and that of the Elkton, Timber Ridge, Accomac, Rural Retreat, Mount Rogers, Marion, Pearisburg, Blacksburg, Macks Mountain, and Mouth of Wilson quadrangle, was begun, all in cooperation with the Conservation and Development Commission of Virginia, Geological Survey. The survey of the proposed Shenandoah National Park was completed. The survey of the Colonial National Monument, Yorktown Battlefield area, was completed in cooperation with the National Park Service, the Conservation and Development Commission of Virginia, and the United States Yorktown Sesquicentennial Commission, and the survey of the Williamsburg area was completed in cooperation with the National Park Service. In cooperation with the War Department and the Fredericksburg and Spotsylvania County Battlefields Memorial Commission, the survey of Fredericksburg and vicinity was completed.

Washington.—In cooperation with the Department of Conservation and Development the survey of the Kalispell quadrangle was begun. For the Forest Service the survey of the Eatonville and Mount Constance quadrangles was begun. The survey of the upper Columbia River from Rock Island Rapids to the mouth of the Snake River was completed in cooperation with the United States Army district engineer at Seattle.

West Virginia.—In cooperation with the State geologist of West Virginia the cultural revision was completed for the Charleston, St. Albans, Guyandot, Louisa, Wayne, and Milton quadrangles and was begun for the Midkiff and Ceredo quadrangles.

Wisconsin.—In cooperation with the Geological and Natural History Survey of Wisconsin the survey of the Boscobel, Boaz, Mondovi, Wabasha, and Lake City quadrangles was completed, and the culture and drainage of the Robbins quadrangle were compiled from aerial photographs. In cooperation with the War Department the survey of Camp McCoy was completed.

Wyoming.—The survey of the Jackson quadrangle was continued and that of the Irwin quadrangle was begun in preparation for geologic mapping.

WATER-RESOURCES BRANCH

N. C. GROVER, *Chief Hydraulic Engineer*

ORGANIZATION AND PERSONNEL

The water-resources branch, like other branches of the Geological Survey, is primarily an agency of research and investigation. It collects systematically for general public information and use facts in regard to the quantity, quality, and utilization of water. The widespread interest in the availability of water for many uses has led to a persistent and increasing demand for reliable data that would serve as a basis for safe and sane developments. During the year the varied work of the branch has been administered under the following units:

Division of surface waters, Carl G. Paulsen, hydraulic engineer, in charge.

Division of ground water, O. E. Meinzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

Division of water utilization, R. W. Davenport, hydraulic engineer, in charge.

The technical force at the end of the year comprised the chief hydraulic engineer, 29 senior hydraulic engineers, 21 hydraulic engineers, 155 associate, assistant, and junior engineers, 2 engineering field aides, 4 senior geologists, 9 associate, assistant, and junior geologists, 1 senior chemist, 6 associate, assistant, and junior chemists, 3 laboratory assistants and apprentices, 1 illustrator, and 1 computer—a total of 233. The clerical force comprised 45 clerks. The changes in personnel during the year show a net increase of 31.

FUNDS

The funds available for Geological Survey work on water resources were as follows:

Gaging streams	\$552, 405. 49
Transfers from Federal agencies	356, 534. 02
Repayments by Federal agencies	6, 081. 69
Cooperative funds furnished by States and municipalities	461, 649. 72
Noncooperative funds furnished by States and municipalities	7, 224. 54
Funds furnished by permittees and licensees of the Federal Power Commission	47, 934. 68
	<hr/>
	1, 431, 840. 14

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Alabama	\$140. 14
Arizona	16, 075. 00
Arkansas	3, 888. 84
California :	
State	\$47, 166. 48
Municipal	24, 975. 87
	<hr/>
	72, 142. 35
Connecticut	7, 000. 00
Florida :	
State	7, 500. 00
Municipal	1, 643. 67
	<hr/>
	9, 143. 67
Hawaii :	
Territory	34, 514. 65
Municipal	11, 789. 24
	<hr/>
	46, 303. 89
Idaho	18, 178. 28
Illinois	5, 994. 63
Indiana	2, 781. 54
Kansas	3, 988. 09
Kentucky	1, 095. 88
Maine	6, 525. 09
Maryland :	
State	1, 100. 00
Municipal	1, 950. 00
	<hr/>
	3, 050. 00

Massachusetts :		
State	\$3, 844. 42	
Municipal	2, 843. 95	
		\$6, 188. 34
Michigan :		
State	5, 499. 76	
Municipal	572. 69	
		6, 072. 45
Minnesota		1, 980. 56
Mississippi		287. 21
Missouri		12, 375. 52
Montana		7, 598. 59
Nebraska		5, 222. 61
Nevada		1, 391. 81
New Hampshire		3, 009. 78
New Jersey		13, 877. 44
New York :		
State	20, 010. 00	
Municipal	271. 95	
		20, 281. 95
New Mexico		1, 363. 08
North Carolina		9, 835. 89
North Dakota		494. 32
Ohio		24, 291. 75
Oregon :		
State	10, 875. 27	
Municipal	702. 65	
		11, 077. 92
Pennsylvania		4, 297. 63
South Carolina :		
State	2, 500. 00	
Municipal	196. 97	
		2, 696. 97
Tennessee		21, 062. 73
Texas		49, 039. 25
Utah		6, 900. 00
Vermont		7, 608. 74
Virginia		24, 921. 89
Washington :		
State	1, 084. 96	
Municipal	4, 835. 93	
		5, 920. 89
West Virginia		4, 300. 00
Wisconsin		7, 043. 34
Wyoming		6, 201. 67
		461, 649. 72

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects was continued in cooperation with the Bureau of Reclamation on the Black Canyon project and on the lower Colorado River.

Indian Service.—Stream gaging was continued for the Indian Service on the Gila and San Carlos Rivers.

National Park Service.—Streams in the Yellowstone National Park were measured during the year at stations maintained in cooperation with the National Park Service.

Department of the Navy.—A study of a water supply for the proposed naval ammunition depot at Lualualei, Oahu, was continued in cooperation with the Bureau of Yards and Docks.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service.

Weather Bureau.—Stream gaging has been continued on the Colorado River in Arizona in cooperation with the Weather Bureau. A study of stream flow was made of the Republican River near Guide Rock, Nebr., of the Tennessee River at Guntersville and Riverton, Ala., and Savannah, Ga., and of the Cumberland River at Celina, Carthage, and Clarksville, Tenn.

Office of Public Buildings and Public Parks of the National Capital.—A study of the flow of Rock Creek was continued in cooperation with the Office of Public Buildings and Public Parks. This study will be of special value in determining the effect of development in the District of Columbia and surrounding suburbs on the flow of the creek. The information collected will be of value in plans for preserving the flow in the creek.

Department of State.—Stream gaging was continued on the Rio Grande on the Mexican boundary and on numerous streams on the Canadian boundary from the Lake of the Woods westward. On the Rio Grande 17 gaging stations were operated. On the Canadian boundary 112 gaging stations were operated and maintained in connection with international problems; 48 of them were international gaging stations operated jointly with the Dominion Water Power and Hydrometric Bureau because of the common interest of the two countries in them.

On the Canadian boundary studies were made of flood-control problems on the Roseau River in Minnesota, the waters of the St. Mary and Milk Rivers in Montana were divided between the two countries pursuant to an order of the International Joint Commission, extensive surface and ground water investigations were made on the Kootenai River in Idaho, and other investigations pertinent to international matters affecting the utilization of streams were conducted. The cost of the work was met by funds transferred to the Geological Survey by the Department of State.

Department of Justice.—Investigations of ground-water supplies were made for the Department of Justice for the proposed Federal reformatory at El Reno, Okla.; at the new Federal detention prison, El Paso, Tex.; at McNeil Island Penitentiary, McNeil Island, Wash.; and at Camp Lee prison farm, Va. An investigation was also made relative to underground water in Hawaii for use in a proceeding to condemn certain land at Lualualei, Oahu.

Corps of Engineers, United States Army.—Stream gaging has been continued in cooperation with the Corps of Engineers in connection with flood control and with studies and reports to be made under House Document 308 of the Sixty-ninth Congress, first session. This work has been carried on in the Boston, Providence, New York, Philadelphia, Baltimore, Washington, Norfolk, Huntington, Wilmington, Charleston, Chattanooga, Nashville, Montgomery, Mobile, Galveston, Savannah, Jacksonville, Vicksburg, Louisville, Cincinnati, St. Paul, Kansas City, Seattle, and Portland Army engineer districts and includes about 655 gaging stations. The cost of this work is met by transfers from the funds of the Corps of Engineers. Dam-site investigations were made on the upper Missouri River and the Rappahannock River, and reports were transmitted to the Chief of Engineers.

Federal Power Commission.—The stream gaging required by the Federal Power Commission in connection with permits and licenses issued for the development of water power under the Federal water power act has been performed or supervised by engineers of the Geological Survey in Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Iowa, Indiana, Kentucky, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, New Mexico, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Tennessee, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming. The operation of constructed projects or projects under construction has been supervised in Arizona, Arkansas, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wisconsin, and Wyoming.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 20 reports and 2 separate chapters. (See p. 5.) At the end of the year 37 other reports were in press.

CHARACTER AND METHOD OF WORK

The study of surface waters, which consists primarily of the measurement of the flow of streams, has been conducted in 47 States, the District of Columbia, and Hawaii at selected gaging stations at which the volume of water carried by the streams is measured and records of stage and other data, from which the daily flow of the stream is computed, are collected. At the end of the year 2,663 gaging stations were being maintained; 247 stations were discontinued and 483 new stations established during the year. Records for about 126 additional stations were received, ready for publication, from Government bureaus and private persons, and several Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

The division of ground water investigates the waters that lie below the surface; their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to the chemical composition of the water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects. During the fiscal year about 63 investigations relating to ground-water and reservoir sites were in progress, and work was conducted in 19 States and Hawaii. The demands of the public for precise information in regard to ground-water resources are becoming more and more exacting with increasing need for the water. In recent years considerable re-

search into the principles of ground-water hydrology has been undertaken in the division in order to provide a more secure basis for ground-water investigations.

Cooperation was continued with the eight State associations of water well drillers and with the American Association of Water Well Drillers.

The division cooperated in the establishment of a section of hydrology of the American Geophysical Union, and Mr. Meinzer was chosen chairman of the section. Papers were presented at the first annual meeting in Washington by Mr. Meinzer, A. M. Piper, C. V. Theis, and G. H. Taylor.

Mr. Meinzer presented a paper entitled "The source and disposal of ground water in the Mokelumne area, California—an application of the inventory method," before the American Society of Economic Geologists at the annual meeting in Toronto. D. G. Thompson gave a paper on "Some ground-water problems in the southeastern section States," at Columbia, S. C., before the southeastern section of the American Waterworks Association. Abstracts of papers relating to ground-water hydrology were prepared for the "Annotated bibliography of Economic Geology" and for foreign abstract journals.

Work was continued in the hydrologic laboratory by V. C. Fishel, working under the direction of A. M. Piper.

The work on quality of water included the analysis of the mineral content of 1,667 samples of water from surface and underground sources. These included some analyses for nearly all the studies of ground water in the different States as noted below. Samples of water were collected from various cities for a report on industrial water supplies which is to supersede Water-Supply Paper 496. Studies of the dissolved and suspended matter in the Colorado River and its tributaries were continued. A paper on the composition of mineral waters was prepared by Mr. Collins for publication in a "Cyclopedia of medicine" now in press.

The work of the division of power resources comprised the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants, a report on the developed water power of the United States, a report containing the monthly and annual figures of output by States for 1930, and compilations of the stocks of coal held by electric public-utility power plants for inclusion in reports of commercial stocks of coal undertaken quarterly by the Bureau of Mines of the Department of Commerce.

The monthly and annual figures of output of electricity and fuel consumption are based on reports submitted by concerns producing electricity for public use. On January 1, 1931, 1,609 companies, operating 3,904 power plants with a total capacity of generators of 34,263,944 kilowatts, were on the list of companies requested to submit reports. Plants whose output is less than 10,000 kilowatt-hours a month are generally not included. Reports are received from plants representing over 95 per cent of the capacity of all plants listed. The output of plants not reporting is estimated.

Annual production of electricity for public use in the United States, 1919-1930

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)
1919.....	38,921,000,000	-----	14,606,000,000	37.5	-----	24,315,000,000	62.5	-----
1920.....	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921.....	40,975,000,000	-5.9	14,970,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922.....	47,654,000,000	+16.3	17,207,000,000	36.1	+14.9	30,447,000,000	63.9	+17.1
1923.....	55,665,000,000	+16.8	19,345,000,000	34.8	+12.4	36,322,000,000	65.2	+19.3
1924.....	59,014,000,000	+6.0	19,969,000,000	33.8	+3.2	39,044,000,000	66.2	+7.5
1925.....	65,870,000,000	+11.6	22,356,000,000	33.9	+11.9	43,514,000,000	66.1	+11.4
1926.....	73,791,000,000	+12.0	26,189,000,000	35.5	+17.1	47,602,000,000	64.5	+9.4
1927.....	80,205,000,000	+8.7	29,875,000,000	37.2	+14.1	50,330,000,000	62.8	+5.7
1928.....	87,850,000,000	+9.5	34,696,000,000	39.5	+16.1	53,154,000,000	60.5	+5.6
1929.....	97,352,000,000	+10.8	34,629,000,000	35.6	-2	62,723,000,000	64.4	+18.0
1930.....	95,936,000,000	-1.5	33,021,000,000	34.4	-4.6	62,915,000,000	65.6	+2.3

Annual consumption of fuel in the production of electricity for public use in the United States, 1919-1930

Year	Coal		Fuel oil		Gas	
	Short tons	Change from previous year (per cent)	Barrels	Change from previous year (per cent)	M cubic feet	Change from previous year (per cent)
1919.....	35,100,000	-----	11,050,000	-----	21,406,000	-----
1920.....	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921.....	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.0
1922.....	34,179,000	+8.2	13,197,000	+9.6	27,172,000	+14.5
1923.....	38,966,000	+14.0	14,684,000	+11.3	31,453,000	+15.7
1924.....	37,536,000	-3.6	16,630,000	+13.3	48,443,000	+54.1
1925.....	40,222,000	+7.1	10,246,000	-38.4	46,521,000	-4.0
1926.....	41,311,000	+2.7	9,399,000	-8.3	53,207,000	+14.4
1927.....	41,888,000	+1.4	6,782,000	-27.8	62,919,000	+18.3
1928.....	41,350,000	-1.3	7,158,000	+5.5	77,326,000	+22.9
1929.....	44,937,000	+8.7	10,124,000	+41.4	112,707,000	+45.5
1930.....	42,898,000	-4.5	9,260,000	-8.5	120,290,000	+6.7

The improvement each year in the utilization of fuel in the generation of electricity by public-utility companies continued, as indicated in the following table:

Average consumption of coal^a per kilowatt-hour by public-utility power plants in the United States, 1919-1930

Year	Pounds	Per cent of rate in 1919	Year	Pounds	Per cent of rate in 1919
1919.....	3.2	100	1925.....	2.1	66
1920.....	3.0	94	1926.....	1.95	61
1921.....	2.7	84	1927.....	1.84	57
1922.....	2.5	78	1928.....	1.76	55
1923.....	2.4	75	1929.....	1.69	53
1924.....	2.2	69	1930.....	1.62	51

^a Oil and gas included as equivalent coal.

Owing to the continuation of the drought, which started in 1929, through the year 1930, the production of electricity by the use of water power was again less than during the previous year.

The regular annual report of the capacity of water wheels in water-power plants in the United States was released February 10, 1931, and the final report of the monthly and annual production of electricity for public use in 1930 was released April 30, 1931.

WORK OF THE YEAR BY STATES

The following table shows by States the number of gaging stations maintained for the collection of stream-flow records and the interest in those stations of the agencies cooperating with the Geological Survey:

Gaging stations and cooperating parties for the year ending June 30, 1891

State or Territory	Geolog- ical Survey alone	Bureau of Recla- mation	Forest Service	Indian Service	Army engi- neers	Weather Bureau	Other Federal bureaus	State coopera- tion	Munic- ipal coopera- tion	Private persons	Counted more than once	Main- tained at end of year	Estab- lished during year	Discon- tinued during year	Regular gagings during year	Miscel- laneous gagings during year
Alabama	1	1			28					5	1	33	1		334	2
Arizona	1			5				61			6	62	7		2,001	25
Arkansas					1	4		13		7	7	18	2	3	89	3
California			20	1			3	277	35	81	136	281	35	11	6,044	525
Colorado		2			10			17	2	2	10	30		5	271	
Connecticut					3			15	2	4	4	50	6		156	6
Delaware																
Florida					10			23		6	13	26	10		205	69
Georgia					15				1	10	10	36	2	2	256	16
Idaho		6	6		14	2	33	108	4	200	93	290	118	126	2,154	64
Illinois					6	2		29	3	35	7	33	1	1	1,777	1
Indiana					14	4		33	2	4	24	33	19		1,888	
Iowa					5				1			6	1	1	81	3
Kansas					22	4		25		1	5	47			386	1
Kentucky					31	1		6		11	12	36	9		238	3
Louisiana					1						10	10	1		10	
Maine					14			21		9	15	29	1		345	24
Maryland and District of Columbia	1				6		1	6	8	1	1	22	2	3	147	71
Massachusetts								24	3	2	4	24	3		216	
Michigan									1	2	1	2	24	24	150	15
Minnesota					14		21	17		4		56	27	6	403	21
Mississippi					9			10		1	10	11	5	2	135	2
Missouri	1				14	3		77		19	22	91	6	8	933	4
Montana					31		36	39		13		119	6		518	4
Nebraska					15						1	18	1		246	
Nevada				1				11		5	1	11	1	1		
New Hampshire					12			45	9	7	17	45	4	1	178	27
New Jersey						1	1					1			298	
New Mexico								16		11	16	23		1	152	
New York					13			103	2	37	52	103	5	1	814	6
North Carolina					30			78		1	31	78	4		523	41
North Dakota					8		9	2		19	19	19	7		106	
Ohio					9	1		106	9	4	23	106	11	5	697	8
Oklahoma					9							9	1	1	57	
Oregon					39	6		93	11	42	98	93	6	6	752	57
Pennsylvania					11		2	94	1	12	18	102	94		71	3
Rhode Island					1										6	
South Carolina					10							17	1		83	6
South Dakota					19			17	3	6	18	17	1		261	2

Tennessee	59	16	11	16	77	10	72	111	77	9	4	599
Texas	16	11	16	77	10	72	111	77	9	4	599	
Utah	3	3	1	1	93	30	38	111	77	9	4	2,074
Vermont	3	3	1	1	21	20	25	57	43	4	3	16
Virginia	33	33	1	1	83	12	46	83	7	4	1	185
Washington	66	66	10	10	101	19	28	109	116	3	16	827
West Virginia	30	30	1	1	29	10	11	59	2	4	3	358
Wisconsin	4	4	1	1	42	10	13	47	10	4	4	284
Wyoming	16	16	1	7	39	3	6	68	43	7	1	6
Hawaii	11	11	1	1	88	13	69	98	9	1	1	547
	8	16	27	11	1,994	145	668	1,044	2,603	483	247	25,816
												1,457

Alabama.—The systematic survey of the ground waters of Alabama was temporarily discontinued, but the water-stage recorder was continued in operation on the springs at Huntsville. A report on ground water resources of northeastern Alabama was completed by W. D. Johnston, Jr., and transmitted to the State geologist.

Arkansas.—The investigation of the source and quantity of ground-water supplies available for rice irrigation in the Grand Prairie region, Ark., was continued by D. G. Thompson, who prepared a report entitled "A quantitative study of the ground water supply of the Grand Prairie region, Ark." This was issued as a 20-page press notice. The work in Arkansas is conducted in cooperation with the State geological survey and the State agricultural experiment station.

California.—Water levels were measured in selected wells in southern California under the direction of F. C. Ebert. The record now covers a period of 27 years. Work was continued with the financial support of the East Bay Municipal Utility District on the investigation of the ground water in the alluvial fan of the Mokelumne River by H. T. Stearns, G. H. Taylor, C. A. McClelland, G. M. Sherwood, R. B. Colby, and R. C. Cady. A progress report on the investigation supplemental to Water-Supply Paper 619 was released. W. N. White spent a month in the area, working in an advisory capacity. Measurement of wells in the Calaveras River area was continued in cooperation with the city of Stockton. Tests of samples of water-bearing materials were made at the laboratories of the State university at Davis. A report on the water table in the Calaveras River area was prepared by T. W. Robinson and G. H. Taylor and released in manuscript form. G. H. Taylor presented a paper on investigations relating to the absorption of precipitation and its penetration to the zone of saturation, at a meeting of the section of hydrology of the Geophysical Union at Washington. This paper was chiefly concerned with experiments now in progress in the Mokelumne area. In a preliminary survey of the quality of surface waters of the State, 105 partial analyses were made. The samples analyzed were representative of different stages for nearly all the gaging stations in the State. A report of this survey was submitted to the State engineer as a basis for planning a comprehensive study of the quality of the surface waters of California.

Florida.—A district office was established at Ocala, Fla., August 4, 1930, with D. S. Wallace, engineer, in charge. A survey of the ground-water resources of Florida was begun in cooperation with the State Geological Survey by V. T. Stringfield, under the direction of D. G. Thompson. Mr. Thompson presented a paper entitled "Problems of water supply in Florida" before the Florida section of the American Waterworks Association. A brief report entitled "Ground-water resources of Florida," by Messrs. Thompson and Stringfield, was published by the State geological survey.

Hawaii.—The comprehensive investigation of the ground waters on the island of Oahu was continued in cooperation with the Territorial Commissioner of Public Lands. Early in July H. T. Stearns was assigned as geologist in charge of the work. K. N. Vaksvik continued his artesian-well studies, and Mr. Stearns spent half of November in an investigation of the high-level water supply available in Lualualei Valley for condemnation proceedings for the Department of Justice. A study of a water supply for the proposed naval ammunition depot at Lualualei, Oahu, was continued for the Bureau of Yards and Docks.

Idaho.—A report on ground water in the Snake River area by H. T. Stearns, Lynn Crandall, and W. G. Steward was completed.

Illinois.—A. G. Fiedler attended the annual meetings of the State well drillers' association and the American Association of Water Well Drillers in Urbana, Ill., and also a joint meeting of the specifications committees of the American Association of Water Well Drillers and the American Specifications Institute in Chicago.

Indiana.—A district office was established at Indianapolis, Ind., August 18, 1930, with H. E. Grosbach, engineer in charge. A. G. Fiedler attended the convention of the Indiana Well Drillers' Association at Des Moines.

Kansas.—A. G. Fiedler presented a paper entitled "Proper well construction" before the annual meeting of the Kansas Waterworks School in Lawrence.

Michigan.—A district office was established at Lansing, Mich., August 25, 1930, with Berkeley Johnson, engineer in charge.

Minnesota.—A. G. Fiedler attended the convention of the Minnesota Well Drillers' Association. A branch office maintained at Minneapolis, in charge of Mr. Fiedler, who is investigating well-drilling methods and cooperating with the State well drillers' associations, was closed June 30.

Montana.—Work was continued by G. M. Hall in the preparation of reports on Big Horn and Fergus Counties.

Nebraska.—L. K. Wenzel was assigned to study ground waters of the Platte River region under the supervision of A. L. Lugin and R. M. Leggette. The work is being done in cooperation with the State conservation and survey division.

New Jersey.—Informal cooperation was continued with the State department of conservation and development and the State water policy commission. The chloride content was determined for 51 samples of well water collected in the vicinity of Atlantic City for observations on the possibility of salt-water contamination.

New Mexico.—Field work was continued by W. N. White in the Mimbres Valley and by S. S. Nye in Lea County. The following cooperative reports were published in the ninth annual report of the State engineer: Preliminary report on the ground-water supply of the Mimbres Valley, by W. N. White; Shallow ground-water supplies in northern Lea County, by S. S. Nye; Recommendations for a more efficient utilization of the Roswell artesian basin, by A. G. Fiedler and S. S. Nye.

North Dakota.—R. M. Leggette investigated dam sites on the Missouri River in North Dakota and prepared and transmitted a report thereon to the Chief of Engineers, United States Army.

Oklahoma.—S. F. Turner made an investigation and prepared a report for the Department of Justice on the water supply available for the proposed reformatory at El Reno, Okla.

Oregon.—Investigations of the ground-water resources of Oregon were continued in cooperation with the State agricultural experiment station. The investigation of the ground water available for irrigation in The Dalles region was continued by A. M. Piper, and T. W. Robinson was assigned to the investigation of the ground-water supply of the Harney Basin. A report on the geology and ground-water resources of The Dalles region was prepared by Mr. Piper and released in manuscript form. He also prepared a summary of the ground-water resources of Yamhill County, which was issued as a press bulletin, and a report on dam sites in eastern Oregon, which was submitted to the conservation branch of the Geological Survey.

Pennsylvania.—A district office was established at Harrisburg, Pa., June 1, 1931, with J. W. Mangan as engineer in charge. The systematic survey of the ground-water resources of the State was continued in cooperation with the State topographic and geologic survey by R. M. Leggette in the north-western part of the State and by S. W. Lohman in the northeastern part.

South Carolina.—A district office was established at Columbia, S. C., November 1, 1930, with A. E. Johnson as engineer in charge.

South Dakota.—R. M. Leggette investigated dam sites on the Missouri River in South Dakota and prepared and submitted a report thereon to the Chief of Engineers, U. S. Army. A. G. Fiedler attended the annual meeting of the State Well Drillers Association.

Tennessee.—Work was continued on a systematic survey of the ground-water resources in Tennessee in cooperation with the State geologist. C. V. Theis was assigned to this work and spent several months in south-central Tennessee under the direction of D. G. Thompson. A report on ground water in north-central Tennessee was completed by A. M. Piper, and a report on the ground-water resources of western Tennessee was completed by F. G. Wells.

Texas.—The systematic survey of the ground-water resources of Texas was continued in cooperation with the State board of water engineers under the direction of W. N. White. Field work was done in the Winter Garden region by W. N. White, T. W. Robinson, P. P. Livingston, and W. A. Lynch. S. S. Nye began field work in the Toyah Basin in Reeves, Ward, and Pecos Counties. A. N. Sayre made a survey of the ground water of Duval County, and work was begun by P. P. Livingston and S. F. Turner on an investigation of the ground-water supply of Harris County and parts of adjoining counties, including the Houston area. J. C. Lonsdale began an investigation of the geology and ground-water resources of Webb County. Reports have been prepared by A. N. Sayre on Medina and Uvalde Counties; by T. W. Robinson, S. F. Turner, A. G. Fiedler, and P. P. Livingston on Zavala and Dimmit Counties and parts of Maverick and La Salle Counties; by J. C. Lonsdale on Atascosa and Frio Counties; and by A. G. Fiedler on the Glen Rose area, in Somervell County. A report summarizing the results of the Texas ground-water work up to January 1, 1931, was prepared by W. N. White in collaboration with O. E. Meinzer and issued as a 35-page press notice. The State depart-

ment of health and the bureau of engineering research, Agricultural and Mechanical College of Texas, continued to cooperate in the ground-water survey.

Virginia.—S. W. Lohman made an investigation of dam sites along the Rappahannock River under the direction of R. M. Leggette and prepared and transmitted a report thereon to the Chief of Engineers, United States Army. A report on the warm springs of Virginia was completed by Frank Reeves and transmitted to the State geologist. Water-stage recorders were operated on the ebbing and flowing spring near Broadway and on the observation well in Arlington County. A report on water-level fluctuations in the Arlington County well was prepared and issued as a press bulletin. An investigation of a proposed municipal water supply for Falls Church was made by R. M. Leggette and L. K. Wenzel, and a report submitted to the mayor of Falls Church. An examination of ground-water conditions at Camp Lee was continued by R. M. Leggette and S. F. Turner for the Department of Justice. The collection of surface-water samples from Virginia was concluded during the fiscal year. Daily samples were collected at 17 gaging stations, and samples were collected at different stages at other stations. A preliminary report was published by the State giving the results for the first year. A final report was prepared giving the analyses for all the stations from which samples were collected.

Washington.—A. M. Piper spent about two weeks investigating ground-water supplies available for the United States penitentiary at McNeil Island for the Department of Justice. He prepared and submitted a report to the conservation branch of the Geological Survey on dam sites on the Hoh and Calawah Rivers.

Wyoming.—A water-stage recorder was continued in operation on the ebbing and flowing spring near Afton.

CONSERVATION BRANCH

HERMAN STABLER, *Chief*

ORGANIZATION AND PERSONNEL

The volume and complexity of the work of the conservation branch, comprising the classification of public lands with respect to mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands, continued to increase during the fiscal year 1931 and was directed through four administrative divisions, as follows:

Mineral classification division, J. D. Northrop, geologist, in charge.
Power division, B. E. Jones, hydraulic engineer, in charge.
Agricultural division, J. F. Deeds, hydraulic engineer, in charge.
Mineral leasing division, H. I. Smith, mining engineer, in charge.

Personnel changes during the fiscal year included 6 separations and 15 additions. On June 30, 1931, the personnel of the branch, both office and field, numbered 158, consisting of 5 geologists, 9 hydraulic engineers, 12 mining engineers, 45 petroleum engineers, 1 classification engineer, 7 agricultural classifiers, 1 chemist, 1 attorney, 22 accountants and draftsmen, and 55 clerical and miscellaneous employees.

FUNDS

The funds appropriated or transferred for the work of the conservation branch in the fiscal year were as follows:

Classification of lands.....	\$180, 480
Supervision of leasing operations, public lands.....	271, 820
Supervision of leasing operations, Indian lands.....	90, 000
Supervision of naval-reserve operations.....	45, 000
Plugging abandoned wells (balance on July 1, 1930).....	43, 191
Federal Power Commission.....	2, 500

682, 991

CORRESPONDENCE

During the year 26,981 letter requests for information or technical reports were received in the Washington office of the branch, together with 37,500 pieces of miscellaneous correspondence for filing or for transmission to the appropriate field office. Within the same period 20,941 letters were answered and 19,900 pieces of miscellaneous correspondence were sent out.

SUMMARY OF LAND-CLASSIFICATION CASES

The activities of the conservation branch with respect to land classification include the preparation of reports in response to requests for data or action on specific cases, the preparation of orders of withdrawal and restoration of lands not involved in specific requests, and the promulgation of broad areal classifications. The following table summarizes activity with respect to requests for data or action on specific cases. The terms "gain" and "loss" signify, respectively, decrease and increase in the number of cases pending. The number of cases acted on was less by about 2,600 than during the preceding year, and the number of cases pending at the end of the year was reduced more than 40 per cent.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1931						Record since receipt of first case	
	Pending July 1, 1930	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1931	Gain or loss during fiscal year	Received	Acted on
General land office requests:								
General.....	407	815	1,222	980	242	+165		
Time extensions.....							2,313	2,313
Oil development.....	1	66	67	66	1		16,195	16,194
Concurrence.....	20	820	840	823	17	+3		
Committee cases—oil.....	609	1,677	2,286	2,214	72	+537	7,357	7,285
Applications for classification as to mineral:								
Oil.....	1,265	4,386	5,651	5,030	621	+644	17,566	16,945
Miscellaneous.....	8	11	19	15	4	+4	854	850
Applications for mineral permits.....	21	317	338	313	25	-4	53,115	53,090
Applications for mineral leases.....	7	159	166	156	10	-3	1,619	1,609
Applications for patent, potassium.....							124	124
Federal Power Commission cases:								
Preliminary permits.....	12	77	89	79	10	+2	196	186
Licenses.....							28	28
Determinations under sec. 24.....	13	42	55	47	8	+5	311	303
Applications for classification as to power resources.....	9	22	31	25	6	+3	448	442
Applications for agricultural classification.....	57	185	242	177	65	-8	1,029	984
Applications for rights of way.....	17	228	245	217	28	-11	6,629	6,601
Irrigation project reports.....	1	8	9	7	2	-1	922	920
Applications under enlarged homestead acts.....	163	270	433	306	128	+35	57,468	57,340
Applications under stock-raising homestead acts.....	1,852	3,807	5,659	4,300	1,359	+493	134,042	132,683
Applications under ground-water reclamation act.....	6	15	21	14	7	-1	965	958
Indian Service requests for information.....	3	3	6	6		+3	9,545	9,545
	4,471	12,908	17,379	14,774	2,605	+1,866		

SUMMARY OF FIELD OPERATIONS BY STATES

Alaska.—Supervised one power project. Expended \$10,000 through the Alaskan branch for supervision of 993 prospecting permits for oil and gas and of 7 leases, 3 licenses, and 25 prospecting permits for coal. Coal produced, 112,961.79 tons; accrued rent and royalty, \$8,612.01.

Alabama.—Examined one tract for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State. Supervised one coal lease. Coal produced, 121,002 tons; accrued rent and royalty, \$12,100.20.

Arizona.—Supervised 11 power projects. Examined 28 tracts for agricultural classification. Supervised on public land 109 prospecting permits for oil and gas, 1 lease and 3 prospecting permits for sodium, and 1 prospecting permit for potassium. No production reported; accrued rent and royalty, \$101.50. Supervised on Indian land in 9 reservations 14 leases and prospecting permits for oil and gas, 9 agency coal mines, 5 leases for vanadium, 3 leases for asbestos, 2 leases for gold, 2 leases for copper, and 1 group of locations for iron ore.

Arkansas.—Supervised 15 prospecting permits for oil and gas and 1 for coal. No production reported.

California.—Investigated structural conditions affecting Goleta Sandspit, in Santa Barbara County, and in cooperation with the geologic branch began a detailed geologic examination of the Kettleman Hills anticline, in Kings and Kern Counties. Supervised 31 power projects. Examined 90 tracts for agricultural classification and began detailed studies of grazing conditions in Mono Lake and Owens Valleys preparatory to administration of lands withdrawn by the act of March 4, 1931 (46 Stat. 1530). Supervised on public land 189 leases and 444 prospecting permits for oil and gas, 5 prospecting permits for coal, 20 prospecting permits for sodium, and 4 leases and 5 prospecting permits for potassium. Oil produced, 9,164,952 barrels; natural gas, 16,994,596,000 cubic feet; natural-gas gasoline, 66,823,634 gallons; coal, 250 tons; sodium minerals, 30,226 tons; accrued rent and royalty, \$942,994.86. Supervised on naval petroleum reserves 25 leases for oil and gas. Oil produced, 5,590,418 barrels; natural gas, 5,123,456,000 cubic feet; natural-gas gasoline, 22,748,665 gallons; accrued rent and royalty, \$1,255,656.50.

Colorado.—Investigated structural and stratigraphic conditions in parts of Archuleta and Delta Counties; examined five tracts for mineral classification and in cooperation with the geologic branch began a detailed geologic survey of the Julesburg Basin. Supervised 11 power projects. Examined 70 tracts for agricultural classification and completed a land-classification map showing agricultural and grazing types in the southwestern part of the State. Supervised on public land 21 leases and 414 prospecting permits for oil and gas; 81 leases, 3 licenses, and 42 prospecting permits for coal; and 2 prospecting permits for sodium. Oil produced, 665,328 barrels; natural gas, 1,709,179,000 cubic feet; natural-gas gasoline, 17,916 gallons; coal, 396,389 tons; accrued rent and royalty, \$86,695.59. Supervised on Indian lands 1 oil and gas lease and 2 agency coal mines.

Florida.—Examined one tract for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State.

Idaho.—In cooperation with the geologic branch began a detailed geologic survey of the Afton quadrangle. Supervised 6 power projects. Investigated storage and power possibilities of the Henrys Fork Basin, the upper Snake River, and the Middle Fork of the Salmon River. Examined 82 tracts for agricultural classification. Supervised on public land 75 prospecting permits for oil and gas, 10 prospecting permits for coal, and 2 leases for phosphate. Coal produced, 987 tons; phosphate, 68,974 tons; accrued rent and royalty, \$6,480.84.

Kansas.—Examined 3 tracts for mineral classification. Supervised 1 prospecting permit for oil and gas.

Louisiana.—Examined 8 tracts for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State. Supervised 13 leases and 2 prospecting permits for oil and gas. Oil produced, 8,919 barrels; natural gas, 690,591,000 cubic feet; natural-gas gasoline, 53,347 gallons; accrued rent and royalty, \$5,048.47.

Mississippi.—Investigated in the field the status of oil and gas prospecting operations throughout the State.

Montana.—Continued detailed geologic investigations in the Sweetgrass Hills and completed a preliminary structure-contour map of the Bears Den-Flat Coulee-Whitlash district, in Liberty and Toole Counties, and a structure-contour map of the Conrad-Great Falls region. Made a geologic reconnaissance of the Crazy Mountain syncline. Prepared a structure-contour map of the eastern two-thirds of the State. Began a detailed geologic survey of the Cedar Creek anticline. Continued through the geologic branch detailed investigations of the coal resources of Richland, Custer, and Powder River Counties. Supervised 29 power projects. Examined 85 tracts for agricultural classification. Supervised on public land 75 leases and 493 prospecting permits for oil and gas, 61 leases, 29 licenses, and 27 prospecting permits for coal, and 1 lease for phosphate. Oil produced, 436,012 barrels; natural gas, 894,407,000 cubic feet; coal, 114,929 tons; accrued rent and royalty, \$72,000.01. Supervised on Indian lands in 3 reservations 144 leases for oil and gas, 2 agency coal mines, 1 prospecting permit for coal, and 1 lease each for silver-lead ore and vermiculite.

Nebraska.—Supervised 3 prospecting permits for potassium.

Nevada.—Supervised 6 power projects. Examined 75 tracts for agricultural classification and continued regional investigations of agricultural utility precedent to grazing classification in the northeastern part of the State. Supervised on public land 87 prospecting permits for oil and gas, 5 prospecting permits for coal, 1 lease and 3 prospecting permits for sodium, 1 lease for phosphate, and 2 prospecting permits for potassium. Coal produced, 29 tons; phosphate, 81 tons; accrued rent and royalty, \$2,247.25. Supervised on Indian land in 1 reservation 6 leases for silver-lead ores and 2 leases for marl.

New Mexico.—Began geologic investigations of the coal resources and structural features of the western part of the San Juan Basin. Continued through the geologic branch similar investigations in the southern and eastern parts of the same basin. Investigated the power possibilities of the Rio Pecos and supervised 3 power projects. Examined 75 tracts for agricultural classification. Supervised on public land 44 leases and 935 prospecting permits for oil and gas, 23 leases and 44 prospecting permits for coal, 3 leases and 55 prospecting permits for potassium, and 4 prospecting permits for sodium. Oil produced, 1,799,815 barrels; natural gas, 5,791,622,000 cubic feet; natural-gas gasoline, 672,848 gallons; coal, 50,713 tons; potassium salts, 4,727 tons; sodium salts, 31 tons; accrued rent and royalty, \$110,056.83. Supervised on Indian lands in 4 reservations 36 leases for oil and gas, 10 agency coal mines, and 1 lease for coal.

North Dakota.—Examined 3 tracts for agricultural classification. Supervised 18 prospecting permits for oil and gas; 60 leases, 13 licenses, and 1 prospecting permit for coal; and 3 prospecting permits for sodium. Coal produced, 363,476 tons; accrued rent and royalty, \$23,283.57.

Oklahoma.—Examined 9 tracts for mineral classification. Continued, in cooperation with the Oklahoma Geological Survey, detailed investigations of the coal resources of the McAlester, Wilburton, and Poteau districts, begun in 1927. Supervised 1 power project. Supervised on public land 17 leases and 11 prospecting permits for oil and gas. Oil produced, 418,063 barrels; natural-gas gasoline, 899,561 gallons; accrued rent and royalty, \$666,888.80. Supervised on Indian lands 9,006 leases for oil and gas, involving 5,018 oil wells and 251 gas wells, 108 leases for coal, and 39 leases for lead and zinc. Lead and zinc concentrates produced, 98,870 tons; market value \$2,694,145.86. Total accrued rent and royalty from all Indian land operations under supervision, \$4,416,079.14. Made 580 field investigations of Indian lands for regulatory, inspectional, or appraisal purposes. Began oil gaging and royalty accounting for 4 Indian reservations.

Oregon.—Investigated storage and power possibilities on the Grand Ronde, Imnaha, Santiam, and Walla Walla Rivers. Examined 43 tracts for agricultural classification. Supervised 4 power projects. Supervised 14 prospecting permits for oil and gas, 2 leases and 8 prospecting permits for coal, 4 prospecting permits for potassium and 1 lease for oil shale. Coal produced, 756 tons; accrued rent and royalty, \$3,206.48.

South Dakota.—Examined 13 tracts for agricultural classification. Supervised 20 prospecting permits for oil and gas and 3 leases for coal. Coal produced, 489 tons; accrued rent and royalty, \$562.

Utah.—Examined for purposes of appraisal certain coal lands in Duchesne and Wasatch Counties. Examined through the geologic branch stratigraphic and structural conditions in parts of Grand and San Juan Counties. Super-

vised 8 power projects. Examined 106 tracts for agricultural classification. Supervised on public land 11 leases and 510 prospecting permits for oil and gas; 41 leases, 2 licenses, and 55 prospecting permits for coal; and 17 prospecting permits for potassium. Oil produced, 5,477 barrels; natural gas, 172,963,000 cubic feet; coal, 830,188 tons; accrued rent and royalty, \$118,549.06. Supervised on Indian land 6 leases for oil and gas and 1 agency coal mine.

Washington.—Supervised 10 power projects. Examined 15 tracts for agricultural classification. Supervised 18 prospecting permits for coal and 1 prospecting permit for sodium. Coal produced, 25,462 tons; accrued royalty, \$6,374.43.

Wyoming.—Investigated geologic structure in Goshen Hole, Goshen County, and examined 1 tract for mineral classification in Natrona County. In cooperation with the geologic branch began a detailed geologic survey of the Afton quadrangle. Furnished to the technical press the results of research investigations to determine the value of ceramic tests in subsurface correlation of Cretaceous shales in the central part of the State. Investigated storage and power possibilities in the Snake River Basin and supervised 4 power projects. Examined 153 tracts for agricultural classification and continued in the southwestern part of the State regional investigations precedent to grazing classification. Made 280 analyses of water, 67 of oil, 22 of natural gas, and 33,418 determinations of oil gravity. Supervised on public land 377 leases and 879 prospecting permits for oil and gas; 35 leases, 5 licenses, and 36 prospecting permits for coal; 2 prospecting permits for sodium; and 1 prospecting permit for potassium. Oil produced, 11,322,546 barrels; natural gas, 15,708,826,000 cubic feet; natural-gas gasoline, 43,027,293 gallons; coal, 1,035,558 tons; accrued rent and royalty, \$2,138,747.82. Made periodic inspection and pressure test of wells shut in on Naval Petroleum Reserve No. 3 and supervised operations begun near the end of the year for mudding and plugging certain reserve wells that were in unsatisfactory condition. Supervised on Indian land 42 leases for oil and gas involving 24 productive wells.

MINERAL CLASSIFICATION DIVISION

The work of the mineral classification division involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation relative to mineral classifications and to orders of withdrawal, modification, and restoration. The results of these field investigations take the form of reports concerning the mineral character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public land, Indian land, and naval oil reserves.

During the fiscal year requests for reports on the prospective value for oil and gas of lands involved in certain types of nonmineral entries and filings totaled 5,651, and reports on 5,030 cases were submitted to the General Land Office.

Some progress was made in 1931 in classifying the vast areas of public land that are still embraced in mineral withdrawals. The results accomplished include net decreases of 197,430 acres in outstanding coal withdrawals and of 15,475 acres in the total area of outstanding petroleum withdrawals.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications June 30, 1931, in acres

State	Coal		Oil		Oil shale		Phosphate		Potash
	Withdrawn	Classified as coal land	Withdrawn	Classified as oil land	Withdrawn	Classified as oil shale land	Withdrawn	Classified as phosphate land	
Alaska.....		56,993							Withdrawn
Arizona.....	139,415								
Arkansas.....		61,160	356						
California.....	17,603	8,720	1,178,392						90,394
Colorado.....	4,142,233	3,052,972	215,370		64,560	962,239			
Florida.....							66,796	130	
Idaho.....	4,761	4,603					391,532	268,299	
Louisiana.....									
Montana.....	7,963,941	8,563,963	465,990	4,233				3,833	
Nevada.....	83,673		1,330,897	67,651			279,944		39,422
New Mexico.....	5,081,011	570,372			123				9,282,160
North Dakota.....	5,954,364	11,178,268	84,894						
Oregon.....	4,361	18,887							
South Dakota.....		260,063							
Utah.....	3,404,043	1,267,697	1,341,264		91,464	2,703,755	277,344	2,987	
Washington.....	691,801	141,444							
Wyoming.....	2,260,604	6,740,594	541,777			460,103	989,149	25,293	
	29,027,810	31,944,983	5,165,740	* 71,894	156,147	4,116,097	2,004,765	300,482	9,411,906

* Includes 2,151 acres of coal land reserved for use of the United States (Coal Reserve No. 1).

* Includes 2,078 acres of coal land reserved for use of the United States (Coal Reserve No. 2).

The following table summarizes the year's work to the extent that it involved technical reports on original applications for permit or lease rights on public lands:

Summary of applications under the mineral leasing acts, fiscal year 1931

Mineral	Prospecting permits				Leases			
	Pending July 1, 1930	Received during fiscal year	Acted on during fiscal year	Pending June 30, 1931	Pending July 1, 1930	Received during fiscal year	Acted on during fiscal year	Pending June 30, 1931
Oil and gas.....	17	35	48	4				
Coal.....	2	186	175	13	7	149	147	9
Phosphate.....						9	8	1
Sodium.....	1	14	11	4		1	1	
Potassium.....	1	82	79	4				
	21	317	313	25	7	159	156	10

In conformity with departmental procedure under the administrative policy initiated March 12, 1929, reports to the number of 2,214 were prepared and submitted to the "Departmental committee to pass on claims in connection with oil and gas permits" during the fiscal year. These involved statements concerning the status of drilling operations, if any, on the permit land and the significance of such operations, active or projected, on adjacent land or elsewhere on the same geologic structure, and included appraisal of any geologic showing submitted by applicants for extension of time in which to comply with permit requirements, for reinstatement of canceled permits, or for allowance of rejected permit applications.

Lands interpreted as withdrawn for examination and classification as to oil shale by Executive order of April 15, 1930 (No. 5327), were classified as nonoil shale and reinterpreted as unaffected by that order as follows: In Sublette, Sweetwater, and Uinta Counties, Wyo., 1,678,108 acres; in Moffat County, Colo., 324,518 acres; and in Summit and Daggett Counties, Utah, 17,383 acres.

On behalf of the Indian Service field examination and appraisal were made of 36,204 acres of land in the Tabby Mountain coal field in Duchesne and Wasatch Counties, Utah, within the original limits of the Uintah Indian Reservation and now a part of the Uintah National Forest. Without specific field investigation, a report was also prepared for the Indian Service concerning the mineral production and mineral resources of the extensive area in southern Montana and northern Wyoming within the original boundaries of the Crow Indian Reservation as determined by the Fort Laramie treaty.

In accordance with the duty delegated to the Geological Survey, definitions of the "known geologic structure" of seven producing oil and gas fields were prepared and promulgated during the year—the Clay Basin gas field, Utah, 6,163 acres, promulgated January 14, 1931; Frannie oil field, Wyoming, 1,946 acres, promulgated January 21, 1931; Urado oil field, Colorado, 232 acres, promulgated January 24, 1931; and Cooper gas field, 5,120 acres; Eaves oil and gas field, 6,668 acres; Jal oil and gas field, 21,063 acres; Lynn oil and gas field, 12,240 acres, all in New Mexico, promulgated June 18, 1931.

The net area included in outstanding definitions of the "known geologic structure" of producing oil and gas fields on June 30, 1931, was 778,851 acres in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Geologic field work required in the solution of the problems of the division is performed in part by summer detail of Washington employees, in part by two division geologists and two assistants with permanent headquarters in Denver, Colo., and in part by the geologic branch at the expense of the conservation branch. The work accomplished in 1930 is included in the branch summary of field operations by States beginning on page 60. Publications in 1931 resulting from the work of division geologists include a preliminary structure contour map of the Bears Den-Flat Coulee-Whitlash districts, Liberty and Toole Counties, Mont., and a map of the Great Falls-Conrad region, accompanied by a brief text, showing areal and structural geology in parts of Cascade, Chouteau, Lewis and Clark, Liberty, Pondera, and Teton Counties, Mont., by the Geological Survey, and a paper on the value of ceramic tests in subsurface correlation of Cretaceous shales in central Wyoming by the American Institute of Mining and Metallurgical Engineers.

POWER DIVISION

The work of the power division consists primarily in obtaining and making available for use in the administration of the public land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public land laws. The extent of this task is indicated by the fact that areas aggregating more than 6,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches. The field projects undertaken during the year are included in the branch summary of field operations by States (pp. 60-62).

Copies of many of the reports on the power possibilities of the streams examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press. Manuscript reports on the water-power resources of the Siletz River Basin, Oregon, and the Quinault, Bogachiel, and Ozette River Basins, Washington, were opened to public inspection during the year.

River surveys were made of the Middle Fork of the Salmon River to its junction with Bear Valley; Panther Creek from its mouth to Napias Creek; Napias Creek from its mouth to the head of the canyon; Loon Creek from its mouth to Warm Springs Creek; Camas Creek from its mouth to Meyers Cove; Big Creek from its mouth to Monumental Creek; Pistol Creek from its mouth to Little Pistol Creek; and Marble Creek from its mouth to the Mitchell ranch—a total of 198 miles in Idaho; and of the Grande Ronde River from the mouth to Rondowa; the Wallowa River from its mouth upstream

23 miles; and the Minam River from its mouth upstream 11 miles—a total of 115 miles in the Grande Ronde River Basin in Oregon.

A plan and profile of the South Fork of the Salmon River was prepared from surveys made the preceding year. These maps also include the East Fork, the Secesh River, Johnson Creek, the Middle Fork of the Payette River above Boom Creek, and Silver Creek, Idaho (220 miles).

A reservoir and dam site on Imnaha River and about 50 miles of the Walla Walla River and its South Fork in Oregon were surveyed. Five additional dam sites were surveyed in Oregon and one in Idaho.

A report on the water-power resources of the McKenzie River and its tributaries, Oregon, was published during the year. Storage and power examinations were also made in the Henrys Fork Basin, Idaho, and the upper Snake River Basin, Wyoming and Idaho. In New Mexico the power possibilities of the Rio Peñasco were investigated. Reports were obtained on field inspections of 55 power projects under permit from the Interior Department.

Administration of the supervision in the field of power projects for the Federal Power Commission is carried on in this office. Investigations and reports have been made on 27 projects, construction and operation are supervised on 128 projects, and cost accounting is being supervised on 10 projects.

The work of the division is briefly summarized in the accompanying tables and in the general summary on pages 60–62.

Pursuant to instructions of the Secretary of the Interior, dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), were called upon for detailed reports of the operation or development of their power systems during the calendar year 1930. The total installation of the reporting companies is 3,276,000 horsepower, of which 2,284,000 horsepower is installed at hydraulic plants. The total energy generated was 7,850,000,000 kilowatt-hours, of which 6,866,000,000 kilowatt-hours was generated by water power. The energy generated was 1,502,000,000 kilowatt-hours less than in 1929 and was the smallest output since 1926. About one-third of the decrease was in the energy generated by water power, and about two-thirds in that generated by fuel.

Power output of permittees and grantees, 1916–1930

Calendar year	Kilowatt-hours	Increase or decrease		Calendar year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1916.....	1,200,000,000			1924.....	6,100,000,000	+190,000,000	+3
1917.....	2,000,000,000	+800,000,000	+67	1925.....	6,930,000,000	+830,000,000	+14
1918.....	3,200,000,000	+1,200,000,000	+60	1926.....	7,800,000,000	+870,000,000	+13
1919.....	3,100,000,000	-100,000,000	-3	1927.....	8,116,000,000	+316,000,000	+4
1920.....	4,300,000,000	+1,100,000,000	+35	1928.....	8,987,000,000	+871,000,000	+11
1921.....	3,725,000,000	-575,000,000	-13	1929.....	9,352,000,000	+365,000,000	+4
1922.....	4,947,000,000	+1,222,000,000	+33	1930.....	7,850,000,000	-1,502,000,000	-16
1923.....	5,910,000,000	+963,000,000	+19				

The following table shows the revenue accrued for occupancy and use of public lands by the power projects mentioned above.

Accrued compensation for occupancy and use of lands under power permits and grants issued by the Interior Department, 1912-1931

State	1912-1915	1916-1920	1921-1925	1926-1930	1931
Alaska.....		\$6,960.00	\$9,280.00	\$2,900.00	\$580.00
Arizona.....	\$515.00	1,265.00	1,900.00	1,900.00	460.00
California.....	3,619.00	9,274.00	9,918.00	9,624.00	1,942.46
Colorado.....	315.00	875.00	1,765.00	1,465.00	250.00
Idaho.....	20.00	1,670.00	1,700.00	1,640.00	316.00
Montana.....	1,255.00	7,562.00	13,314.00	28,183.00	7,457.00
Nevada.....	281.00	2,245.00	2,570.00	3,565.00	1,442.63
New Mexico.....		20.00	60.00	275.00	98.00
Oregon.....	60.00	100.00	700.00	700.00	225.00
Utah.....		2,568.00	4,395.00	4,460.00	1,180.50
Washington.....	15.00	156.00	631.00	3,675.00	1,266.00
Wyoming.....		70.00	175.00	290.00	65.00
Minnesota.....		20.00	25.00	20.00	
Accumulation.....	6,060.00 6,060.00	32,805.00 38,882.00	46,433.00 85,318.00	58,697.00 144,015.00	15,273.89 150,269.00

Accrued charges for the unauthorized occupancy of public lands by power projects prior to the issuance of licenses therefor by the Federal Power Commission amount to \$94,605.

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1930	Eliminated prior to July 1, 1930	Reserves outstanding prior to July 1, 1930	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1931
Alabama.....	2,377		2,377			2,377
Alaska.....	303,481	520	302,961	12,638	31,644	284,155
Arizona.....	1,338,719	139,844	1,198,875	169	1,353	1,197,691
Arkansas.....	29,674	360	29,314	44	80	29,278
California.....	1,456,358	39,122	1,417,236	9,649	14,707	1,412,208
Colorado.....	559,082	96,020	463,062	60	2,809	460,263
Florida.....	1,131		1,131			1,131
Idaho.....	652,696	201,211	451,485	815	3,541	448,759
Michigan.....	1,240		1,240	6		1,246
Minnesota.....	19,062	532	18,530			18,530
Mississippi.....	3		3			3
Missouri.....				11		11
Montana.....	307,609	97,653	209,956	820	2,270	208,506
Nebraska.....	761		761			761
Nevada.....	359,313	1,845	357,468	1,366		358,834
New Mexico.....	272,960	11,243	261,717		4,880	266,607
Oregon.....	812,517	159,181	653,336	8,207	28,078	633,465
South Dakota.....	636		636	160		796
Utah.....	782,306	130,985	651,321	3,639	6,357	648,603
Washington.....	472,954	107,716	365,238	7,572	1,141	371,669
Wisconsin.....	1,906	226	1,680			1,680
Wyoming.....	275,802	76,284	199,518	3	181	199,340
	7,650,607	1,062,742	6,587,865	45,649	97,041	6,536,473

Summary of outstanding water-resources withdrawals and classifications June 30, 1931, in acres

State	Power reserves					Reservoir with- drawals	Public water reserves
	With- drawals	Classifi- cations	Desig- nations *	Miscel- laneous	Total		
Alabama.....	120	1, 735		522	2, 377		
Alaska.....	88, 275	109, 655		86, 225	284, 155		
Arizona.....	373, 899	49, 861	524, 200	249, 721	1, 197, 681	23, 040	20, 990
Arkansas.....	21, 954	1, 550		5, 774	29, 278		
California.....	286, 915	368, 530		756, 763	1, 412, 208	45, 264	200, 001
Colorado.....	210, 519	193, 438		56, 326	460, 283	1, 728	9, 360
Florida.....				1, 131	1, 131		
Idaho.....	196, 031	234, 098		18, 630	448, 759		17, 087
Michigan.....	1, 240			6	1, 246		
Minnesota.....	12, 309			6, 221	18, 530		
Mississippi.....				3	3		
Missouri.....				11	11		
Montana.....	126, 994	55, 547		25, 965	208, 506	9, 080	9, 977
Nebraska.....	761				761		
Nevada.....	26, 627	86, 633		245, 574	358, 834		15, 536
New Mexico.....	115, 647	49	141, 161		256, 857		9, 959
North Dakota.....						1, 091	
Oregon.....	319, 195	204, 248	14, 692	95, 330	633, 465	18, 603	28, 301
South Dakota.....				796	796		240
Utah.....	435, 235	178, 126		35, 542	648, 903	80	40, 626
Washington.....	99, 330	193, 320		79, 019	371, 669	31, 797	929
Wisconsin.....				1, 680	1, 680		
Wyoming.....	79, 935	77, 563		41, 842	199, 340	1, 714	85, 945
	2, 394, 986	1, 754, 353	680, 053	1, 707, 081	6, 536, 473	132, 397	438, 352

* Designated and not otherwise withdrawn.

AGRICULTURAL DIVISION

The functions of the agricultural division consist of the classification of lands under the enlarged homestead law as nonirrigable; the classification of lands under the Nevada ground-water reclamation law as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family; and the preparation of areal-classification reports showing the agricultural utility of lands in important public-land regions.

Classifications are made in accordance with the results of field examinations by the members of the division and with information obtained from other sources. The work of the division is planned with the primary purpose of acting on pending applications for classification under the above-mentioned laws and to provide in advance the basis for appropriate action on new applications. The number of cases received and acted on during the fiscal year is shown in the general summary of cases (p. 59). There was a decrease of about 5 per cent in the number received, and the arrearage was 24 per cent less at the end of the year than at the end of the fiscal year 1930.

Summary of enlarged homestead designations, in acres

[Areas classified as arid and nonirrigable; residence by entrymen required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 132), applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat. 963), applicable to Kansas; act of Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply; residence by entrymen not required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho)]

State	Designations prior to July 1, 1930	Cancellations prior to July 1, 1930	Designations outstanding prior to July 1, 1930	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1931
Arizona.....	31, 533, 384	13, 363, 989	18, 169, 395	800	16, 040	18, 154, 155
California.....	13, 382, 193	240, 453	13, 141, 740	2, 354	216, 880	12, 927, 214
Colorado.....	33, 976, 042	196, 428	33, 779, 614	2, 740	-----	33, 782, 354
Idaho:						
Total.....	13, 756, 316	461, 405	13, 294, 911	1, 840	* 320	13, 296, 431
Nonresidence.....	573, 227	4, 233	568, 994	480	-----	569, 474
Kansas.....	652, 244	-----	652, 244	160	-----	652, 404
Montana.....	53, 494, 879	245, 728	53, 249, 151	2, 077	-----	53, 251, 228
Nevada.....	50, 219, 304	3, 580, 717	46, 638, 587	-----	320	46, 638, 267
New Mexico.....	43, 853, 436	227, 892	43, 625, 544	1, 400	120	43, 626, 824
North Dakota.....	12, 281, 527	3, 848	12, 277, 679	1, 030	-----	12, 278, 709
Oregon.....	21, 283, 751	989, 902	20, 293, 849	800	11, 320	20, 283, 329
South Dakota.....	16, 343, 341	348, 170	15, 995, 171	-----	-----	15, 995, 171
Utah:						
Total.....	11, 754, 830	1, 190, 607	10, 564, 223	2, 467	* 7, 220	10, 559, 470
Nonresidence.....	1, 656, 151	502, 883	1, 153, 268	1, 947	6, 220	1, 148, 995
Washington.....	6, 660, 772	251, 842	6, 408, 930	320	-----	6, 409, 250
Wyoming.....	29, 790, 181	162, 043	29, 628, 138	1, 588	-----	29, 629, 726
	338, 982, 200	21, 263, 024	317, 719, 176	17, 576	252, 220	317, 484, 532

* 320 acres in Idaho and 1,000 acres in Utah previously designated under secs. 1-5, now under sec. 6.

Summary of stock-raising homestead designations, in acres

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family (act of Dec. 29, 1916, 39 Stat. 862)]

State	Designations prior to July 1, 1930	Cancellations prior to July 1, 1930	Designations outstanding prior to July 1, 1930	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1931
Arizona.....	14, 217, 259	1, 022, 890	13, 194, 369	56, 250	15, 040	13, 235, 579
Arkansas.....	1, 120	-----	1, 120	-----	-----	1, 120
California.....	8, 127, 965	3, 400	8, 124, 565	58, 274	8, 040	8, 174, 799
Colorado.....	9, 202, 446	20, 400	9, 182, 046	187, 151	680	9, 368, 517
Florida.....	480	-----	-----	-----	-----	-----
Idaho.....	5, 636, 527	1, 894	5, 634, 633	100, 625	120	5, 735, 138
Kansas.....	115, 779	-----	115, 779	520	-----	116, 299
Michigan.....	3, 491	-----	3, 491	-----	-----	3, 491
Mississippi.....	160	-----	160	-----	-----	160
Montana.....	15, 794, 733	17, 241	15, 777, 492	155, 018	33, 960	15, 898, 550
Nebraska.....	209, 199	-----	209, 199	3, 560	-----	212, 759
Nevada.....	636, 088	3, 120	632, 968	20, 754	-----	653, 722
New Mexico.....	31, 635, 775	756	31, 635, 019	257, 616	27, 360	31, 865, 275
North Dakota.....	399, 459	-----	399, 459	4, 948	-----	404, 407
Oklahoma.....	86, 434	-----	86, 434	2, 696	-----	89, 130
Oregon.....	6, 416, 476	3, 128	6, 413, 348	80, 254	40	6, 493, 562
South Dakota.....	6, 536, 333	550	6, 535, 783	11, 797	-----	6, 547, 580
Utah.....	2, 073, 242	7, 875	2, 065, 367	94, 135	400	2, 159, 102
Washington.....	702, 735	1, 174	701, 561	10, 933	120	712, 374
Wyoming.....	20, 840, 850	7, 653	20, 833, 197	274, 037	80	21, 107, 154
	122, 636, 551	1, 090, 561	121, 545, 990	1, 318, 568	85, 840	122, 778, 718

By blanket order of withdrawal creating Public Water Reserve No. 107, which received Executive approval April 17, 1926, every smallest legal subdivision of the public-land surveys which is vacant unappropriated public land and contains a spring or water hole and

all land within a quarter of a mile of every spring or water hole located on unsurveyed public land were reserved for public use and in aid of pending legislation. This order obviated the necessity for future withdrawals of specific tracts containing springs or water holes valuable for stock watering, but it requires a determination with respect to all entries of public land whether or not any of the subdivisions involved are in fact affected by it. On the basis of such determination, orders of interpretation are issued from time to time, listing by legal subdivisions of the public-land survey any tracts found to contain a water supply affected by the order. New withdrawals of this type are made to reserve lands along streams and are also made from time to time for special public purposes. The extent of outstanding reserves of this type and of current action affecting them is shown in the following table:

Public water reserves, in acres

[Includes areas withdrawn under the act of June 25, 1910 (41 Stat. 1063), as amended by the act of August 24, 1912 (37 Stat. 497), and reserved for public use of springs or water holes in accordance with the provisions of sec. 10 of the act of December 29, 1916 (39 Stat. 862), or for watershed protection, drainage reservoirs, or other similar miscellaneous public purposes involving water conservation.]

State	Reserved prior to July 1, 1930	Eliminated prior to July 1, 1930	Reserves outstanding prior to July 1, 1930	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1931
Arizona.....	23, 347	2, 607	20, 740	330	135	20, 935
California.....	207, 009	7, 658	199, 351	920	240	200, 031
Colorado.....	10, 145	500	9, 645	160	440	9, 365
Idaho.....	15, 827	410	15, 417	1, 680	-----	17, 097
Montana.....	11, 089	1, 392	9, 697	440	160	9, 977
Nevada.....	17, 591	3, 250	14, 341	1, 560	365	15, 536
New Mexico.....	12, 401	2, 205	10, 196	640	880	9, 956
Oregon.....	28, 189	1, 288	26, 901	1, 680	280	28, 301
South Dakota.....	240	-----	240	-----	-----	240
Utah.....	45, 826	7, 596	38, 230	1, 820	-----	40, 056
Washington.....	920	-----	920	-----	-----	920
Wyoming.....	98, 285	14, 140	84, 145	1, 880	80	85, 945
	470, 869	41, 046	429, 823	11, 110	2, 580	438, 353

In the field broad areal studies were continued in the Colorado Basin region in southwestern Wyoming, and a land-classification map of southwestern Colorado was published. Intensive grazing studies were begun in Mono Lake and Owens Valleys, Calif., preparatory to the administration of lands withdrawn under the act of March 4, 1931.

During the fiscal year the area designated under the Nevada ground water reclamation act was increased 8,800 acres, to a total of 1,699,975 acres. Outstanding withdrawals under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, aggregating 61,397 acres, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

MINERAL-LEASING DIVISION

WORK OF THE DIVISION

The work of the mineral-leasing division is supervisory (both inspectional and regulatory) with respect to operations on the public domain for the discovery and development of petroleum, natural gas,

oil shale, coal, phosphate, sodium, potassium, and sulphur; on certain land grants for gold, silver, and mercury; on naval petroleum reserves for petroleum and natural gas; and on Indian lands for coal, oil and gas, zinc, lead, iron, silver-lead, uranium, vanadium, and radium ores, vermiculite, asbestos, asphalt, volcanic ash, and stone. This work is done with a minimum of administrative supervision from Washington through district offices at or near the primary centers of mining or drilling activity, under the direction of responsible engineers who have full authority to represent the Secretary within their jurisdiction and to order compliance with the law and regulations under which operations are conducted.

BENEFITS DERIVED FROM MINERAL LEASING

Since October 20, 1914, the date of approval of the law providing for the leasing of coal lands in Alaska, \$69,299,916.91 has accrued from royalties, rentals, and bonuses by reason of mineral production on public land. During the past fiscal year \$3,607,396.19 accrued from 6,573 leases, licenses, and prospecting permits, involving more than 10,000,000 acres of land in 19 States and Alaska.

Under the mineral-leasing act of 1920 the public-land States receive, without expense, 37.5 per cent of all money derived from leases and permits within their respective borders and participate in the benefits resulting from the expenditure of an additional 52.5 per cent of the income by the Bureau of Reclamation. Incidental benefits include taxes on production and on property used in the development of leases, which in some States amount to more than one-fifth of the total income from taxes. Only 10 per cent of the income from mineral-leasing operations is retained in the United States Treasury.

Alaska, by special legislation, receives all net profits from the operation of Government mines and all royalties and rentals from mineral leases. The money thus derived is applied to the reimbursement of the Federal Government for the construction of railroads in that Territory.

ACTIVITIES ON PUBLIC LAND

Supervisory activity on public land is governed by the principles of true conservation—that is, wise use—of the mineral resources involved and is directed to enforcement of provisions included by Congress in the various leasing laws to assure the development of publicly owned mineral deposits with reasonable diligence, skill, and care, without undue waste and without monopoly; with payment of royalties on the amount or value of product; with sale of product at reasonable prices; and with protection of the interests of the United States and due safeguard to the public interest.

An outstanding example of conservation during the fiscal year was the consummation of cooperative or unit plans of development for the Kettleman Hills North Dome oil and gas field, California, and the Little Buffalo Basin gas field, Wyoming. This was accomplished pursuant to an act of Congress approved July 3, 1930, which expired January 31, 1931. A further act approved March 4, 1931, amending the general leasing law of February 25, 1920, reaffirmed the policy of conservation and reauthorized cooperative or unit plans for the purpose of conserving the natural resources in any single oil

or gas pool or field. Under this later act unit plans for several other oil and gas fields are being perfected.

Waste of natural gas in two fields in southern California was decreased more than 50 per cent during the last five months of the fiscal year as a result of the Secretary's order of January 20, 1931 (No. 482), imposing a penalty on all gas wasted or blown into the air. A curtailment in the production of oil and gas and in the drilling of unnecessary wells was effected pursuant to another provision of the same departmental order, which stipulated, in lieu of actual drilling and production from Federal properties, the payment of an amount estimated to reimburse the United States for current loss of royalty by reason of oil or gas drainage through neighboring wells.

Special effort was made during the year to establish the double-entry system of mining in all wagon coal mines under supervision. In one district 16 miles of coal outcrop was surveyed and mapped, and plans for the development of 29 mines were prepared and given to the respective lessees and permittees. Similar work was conducted in other States where there are coal mines on public land.

Contrary to normal expectation, the general decrease in development and production activities during the year resulted in a substantial increase in supervisory duties necessary to prevent loss of or damage to minerals and mineral-bearing formations by reason of suspension or curtailed operations and of economy measures adopted by the operators. In general the demands for engineering advice and assistance are continually increasing as the number of permittees, lessees, and licensees increases, as the supervisory duties under the leasing laws are more clearly defined and enlarged, and as the competence and impartiality of the supervisors become more widely known.

Engineers were called on during the year to assist in fighting and sealing off six fires in abandoned coal mines. Eight coal-outcrop fires in four States were also extinguished, and work is continuously in progress to reduce both the number and effect of such fires.

During the year 29 improperly abandoned oil and gas test wells on public land were properly plugged and abandoned, at a cost to the Government of \$40,000, making a total of 52 such wells abandoned at an aggregate cost of \$80,000 since 1928. Reimbursement to the Government under surety bonds is expected to amount to approximately 20 per cent of these expenditures. Action under departmental instructions of April 23, 1928, resulted in the plugging, without expense to the Government, of 18 such wells during the year, making an aggregate of 81 wells so abandoned since 1928, with an estimated saving of \$30,000 to the Government.

The conservation and protection of human life and health has always been an important factor in the mineral-leasing program. Since the beginning of supervisory work in 1920 there have been no fatal accidents in coal mines on leased Government lands in the States of California, Montana, Nevada, Oregon, South Dakota, and Washington. The prevention of mining accidents and the conservation of natural resources have been materially aided by the continued introduction of improved mining methods, including during the year the extension of the use of rock dust in seven additional mines and the use of electric cap lamps in four additional mines.

The Joseph A. Holmes Safety Association presented a certificate of honor to the Tri-State Zinc and Lead Ore Producers Association, of Picher, Okla. for its effective work in increasing health and safety in the mines of that region, most of which are on restricted Indian lands under supervision by this division. The association cited, in cooperation with the Metropolitan Life Insurance Co. and the United States Bureau of Mines, organized and operated the first health clinic for miners in the United States.

During the fiscal year 426 leases, licenses, and prospecting permits were issued, involving 433,277.54 acres.

Leases, licenses, and permits issued, fiscal year 1931

	Num- ber	Acres		Num- ber	Acres
Leases:			Permits:		
Oil and gas.....	103	63, 102. 26	Oil and gas.....	91	142, 196. 47
Coal.....	34	3, 876. 47	Coal.....	93	76, 868. 04
Potash.....	1	1, 320. 00	Potash.....	58	125, 678. 87
Phosphate.....	1	1, 280. 00	Sodium.....	11	17, 110. 28
Sodium.....	1	406. 20			
	140	69, 983. 93		253	361, 853. 61
Licenses.....	33	1, 440. 00	Grand total.....	426	433, 287. 54

During the same period 20 coal leases, 20 coal permits, 1 coal license, 1 potash lease, 9 potash permits, 4 sodium permits, 7 oil and gas leases, and 1,558 oil and gas permits were canceled, and 55 coal permits, 11 coal licenses, 29 potash permits, and 6 sodium permits expired by limitation—a total of 1,721 for 1931 as compared with 9,195 for 1930.

The following table shows the total number of leases, licenses, and permits involving public land in effect at the end of the year:

Mineral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey, June 30, 1931

State	Coal						Oil and gas			
	Leases		Permits		Licenses		Leases		Permits	
	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres
Alaska.....	7	7, 867. 28	25	35, 325. 07	3	30. 00			993	2, 481, 624
Alabama.....	1	1, 840. 00								
Arizona.....									109	228, 406. 47
Arkansas.....			1	2, 079. 88					15	23, 776. 20
California.....			5	7, 375. 29			214	61, 503. 68	444	387, 153. 04
Colorado.....	81	12, 609. 20	42	22, 952. 03	3	120. 00	21	16, 495. 13	414	588, 898. 30
Idaho.....			10	9, 894. 19					75	146, 432. 60
Kansas.....									1	156. 32
Louisiana.....							13	1, 076. 07	2	323. 80
Montana.....	61	6, 203. 38	27	9, 698. 50	29	1, 158. 60	75	15, 424. 26	498	571, 655. 03
Nevada.....			5	9, 484. 04					87	209, 292. 90
New Mexico.....	23	14, 743. 38	44	66, 290. 65			44	38, 010. 34	935	2, 011, 174. 52
North Dakota.....	60	6, 615. 08	1	40. 00	13	599. 93			13	20, 011. 25
Oklahoma.....									6	2, 489. 28
Red River.....							17	730. 20	5	106. 50
Oregon.....	2	1, 895. 24	8	5, 039. 54					14	30, 799. 35
South Dakota.....	3	159. 04							20	25, 312. 09
Utah.....	41	27, 298. 77	55	71, 717. 43	2	160. 00	11	6, 543. 26	510	931, 766. 55
Washington.....			18	15, 300. 86						
Wyoming.....	35	14, 096. 45	36	29, 325. 55	5	200. 00	377	115, 402. 25	879	1, 806, 850. 80
	314	93, 327. 82	277	284, 523. 03	55	2, 268. 53	772	255, 185. 19	5, 015	9, 465, 908. 00

* Includes 15 leases on Naval Petroleum Reserves Nos. 1 and 2 under the act of Feb. 25, 1920, and 10 on Naval Petroleum Reserves Nos. 1 and 2 under the act of Oct. 2, 1917; total area, 10,608.97 acres.

• Oil and gas permits in Louisiana include the right to lease sulphur deposits discovered while prospecting for oil and gas.

Mineral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey, June 30, 1931—Contd.

State	Sodium				Potash			
	Leases		Permits		Leases		Permits	
	Num-ber	Acres	Num-ber	Acres	Num-ber	Acres	Num-ber	Acres
Arizona.....	1	405.20	3	5,163.84			1	634.77
California.....			20	34,386.77	4	7,783.80	5	10,871.91
Colorado.....			2	2,160.00				
Nebraska.....							3	510.00
Nevada.....	1	1,440.00	3	6,400.00			2	5,121.40
New Mexico.....			4	4,931.97	3	7,674.39	55	121,317.15
North Dakota.....			3	524.83				
Oregon.....	1						4	5,848.94
Utah.....							17	27,720.00
Washington.....			1	40.00				
Wyoming.....			2	1,045.78			1	1,760.00
	2	1,845.20	38	54,653.19	7	15,458.19	88	173,784.26

Also Idaho, 2 phosphate leases, 1,700 acres; Montana, 1 phosphate lease, 1,280 acres; Nevada, 1 phosphate lease, 180 acres; Oregon, 1 oil shale lease, 2,680 acres. Total leases, 1,100; licenses, 55; permits, 5,418; grand total, 6,573.

Although the total number of leases, licenses, and permits under supervision decreased 16.5 per cent during the past fiscal year, the number of leases increased 10.9 per cent and of licenses 61.8 per cent. The only decrease was in the number of oil and gas permits, amounting to 22.8 per cent, and was a consequence of the President's policy of oil and gas conservation, announced March 12, 1929.

PRODUCTION ON PUBLIC LANDS

Coal.—During the fiscal year 1931 3,053,189.08 tons of coal was produced from public land in 14 States, from which \$370,350.52 accrued in rents, royalties, and bonuses. This was an increase in production of 0.43 per cent over the preceding year, and the number of operating coal mines increased 17 per cent, to a total of 79 railroad shipping mines and 303 wagon mines. In Wyoming the Union Pacific Coal Co. recently completed a 790-foot shaft and the Rock Springs Fuel Co. a 350-foot shaft, and the Blue Blaze Coal Co. started sinking a new air shaft. In addition to these, many new developments are under way in Wyoming and elsewhere. The Union Pacific, the Northern Pacific and the Denver & Rio Grande Western Railroads are all operating, through subsidiaries, coal mines on leased public lands, and the Great Northern Railway has applied for a coal lease in Montana. The installation of mechanical stokers in heating plants has greatly increased the use of slack coal, which heretofore has been a drug on the market. Eight core-drill test holes for coal were completed during the year, to an aggregate depth of 3,600 feet, and eight churn-drill holes to an aggregate depth of 910 feet, in four States.

Potash.—There were 7 potash leases involving 15,458.19 acres and 88 potash permits involving 173,784.26 acres in effect in eight States at the end of the fiscal year. From one leasehold in New Mexico 4,726.94 tons of potash (K_2O) was produced. The first commercial shipment of potash from leased public land contained 26.80 per cent K_2O and was made March 7, 1931.

The importance to the American farmer of this new domestic source of potash can not be overemphasized. It is the culmination of a nation-wide search for potash begun as a result of the abrogation of American contracts in 1910 and the shortage felt when German potash supplies were cut off during the World War. In 1913 the United States imported 270,720 short tons of potash (K_2O), valued at \$18,073,865, and in 1930 domestic production amounted to 61,270 short tons, or only about 15 per cent of the current American demand. Under the stimulus of war prices domestic production of potash reached a peak of 54,803 short tons (K_2O) in 1918, but production costs were so high that the American industry could not meet foreign competition.

Despite the known existence of potash brine in the Permian salt beds of Texas since 1912, the collapse of the war-time potash industry made private capital hesitant to attempt exploitation. The results of the first governmental core tests for potash, authorized March 4, 1911, only added to the general impression that potash could not be produced from the American sources then known at a cost low enough to compete with foreign supplies.

In August, 1925, the Snowden-McSweeney interests drilled a test hole for oil on public land in Eddy County, N. Mex., and the potassium mineral sylvite was recognized in the cuttings. The first application for a potash prospecting permit in this area was made August 6, 1925, and the first lease was issued November 21, 1929. Since the identification of sylvite in the Snowden-McSweeney well in 1925 more than 100 test holes have been drilled in the Permian salt basin, 50 of them diamond-drill holes with an aggregate depth in excess of 76,000 feet. Twenty-one of these core tests were drilled at Federal expense under a program approved June 25, 1926, and in all of them potash-bearing salts were discovered.

In some parts of the area under lease as many as 40 potash-bearing zones have been recognized, among them 10 sylvite zones and many beds of polyhalite. The advantage of sylvite over polyhalite as a potash ore is evident from the relative potassium content of the two minerals. Pure sylvite is 100 per cent KCl, equivalent to 63.2 per cent of K_2O , whereas polyhalite contains the equivalent of only 15.6 per cent K_2O . Only a very small amount of sylvite ore richer than 30 per cent K_2O is mined in Europe.

In December, 1929, after prospecting for five years, the United States Potash Co. started an exploratory shaft 3 miles from the Snowden-McSweeney well. The shaft was completed to a depth of 1,062 feet one year later. When a commercial bed containing sylvite was cut in the shaft at a depth of 980 feet, an analysis of it showed a K_2O equivalent of 29.86 per cent, which checked within 2 per cent the amount of potash expected from the core drill records. Drifts were begun, and shipments were started soon after this bed was reached.

It is estimated that nearly a million dollars had been spent by various interests in southeastern New Mexico up to the end of the fiscal year, in prospecting and drilling for potash, sinking the shaft referred to, and purchasing the equipment necessary for preliminary mine development.

Three churn-drill test holes for potash were sunk during the year to an aggregate depth of 300 feet in New Mexico, and three similar holes having an aggregate depth of 2,067 feet were drilled in Salt Valley, Utah. In the Utah locality a well drilled for oil to a depth of 3,500 feet entered the salt-bearing zone at 885 feet and passed out of it at a depth of 3,350 feet. Core was taken for 680 feet of this distance, and more than 200 analyses for potash were made. The location for the first Government test for potash in Utah, in Salt Valley, was approved in June, 1931, and drilling was expected to begin in August.

Sodium.—There are two sodium leases, involving 1,845.20 acres, and 88 sodium permits, involving 54,653.19 acres, in effect in 8 States. From one leasehold in Nevada 40 tons of salt cake was sold and approximately 700 tons was harvested and stored. From the leasehold in Arizona no sodium was produced during the year. Prospecting by drilling was begun under one prospecting permit in California, and prospecting by shaft and open-cut methods was begun by permittees in Colorado. Sodium minerals were also produced under potash leases in California to the extent of 7,508 tons of borax and 22,718 tons of soda ash.

Phosphate.—Four phosphate leases were in effect at the end of the fiscal year, two in Idaho and one each in Nevada and Montana. The production of phosphate from the Idaho leases amounted to 68,974.33 tons, and from the Nevada lease to 80.72 tons. No phosphate was produced in Montana, but two core test holes were drilled to a depth of 675 feet.

Oil shale.—Under one outstanding oil-shale lease involving public land in Oregon no development work was undertaken during the year.

Oil and gas.—Production of oil and gas from public lands during the fiscal year compared with production during 1930 as follows: Crude oil decreased 3,598,898 barrels, or 18.12 per cent; natural gas increased 2,838,068,000 cubic feet, or 7.25 per cent; natural gasoline increased 10,029,297 gallons, or 9.88 per cent. The effect of overproduction and low prices on public-land activities in the major oil-producing States is shown by a decrease in the number of wells completed to production and an increase in the number of wells shut in. Completions decreased from 209 during the calendar year 1929 to 148 during

1980, or 80 per cent, and from 78 during the first 6 months of 1980 to 30 during the corresponding period in 1981, or approximately 59 per cent; wells shut in increased from 599 on July 1, 1980, to 699 on July 1, 1981, or approximately 17 per cent.

Detailed statistics are shown in the following tables, in which the figures for 1980 are included in the 5-year total for 1926-1930 and also shown separately for comparison with 1981.

Coal produced from leases, licenses, and permits on public lands, in tons, by fiscal years

State	1912-1925	1926-1930	1930	1931	1912-1981
Alaska.....	455,497.43	527,740.36	121,825.20	112,961.79	1,096,496.56
Alabama.....		322,926.00	136,661.00	121,002.00	443,928.00
California.....		104.00	62.00	250.00	354.00
Colorado.....	2,028,940.29	2,166,953.40	434,871.08	396,389.11	4,592,282.80
Idaho.....		1,833.30	1,366.65	986.52	2,819.82
Montana.....	252,973.58	1,304,058.74	247,864.94	114,929.27	1,671,958.56
Nevada.....		91.15		26.00	120.15
New Mexico.....	74,427.26	357,129.62	74,857.99	50,713.21	482,270.09
North Dakota.....	453,695.38	1,693,443.14	447,627.36	363,476.32	2,510,614.64
Oregon.....	688.97	8,796.66	3,321.70	755.50	10,243.13
South Dakota.....	1,842.63	2,772.82	402.58	489.29	8,104.74
Utah.....	487,803.62	2,117,190.17	649,383.27	820,187.56	3,434,661.33
Washington.....	164,280.43	88,508.03	6,899.43	25,461.74	278,250.20
Wyoming.....	4,465,885.23	5,187,978.63	914,932.11	1,085,567.77	10,689,421.53
	8,385,534.82	13,729,522.92	3,039,975.31	3,053,189.08	25,168,248.82

Sodium salts produced from public lands, in tons, by fiscal years

State	1921-1925	1926-1930	1930	1931	1921-1981
California.....	3,145.30	73,362.37	28,736.47	30,226.00	108,733.67
Nevada.....	248.25	2,546.08	585.59		2,794.33
New Mexico.....				30.53	30.53
	3,393.55	75,908.45	29,322.06	30,256.52	109,658.52

Phosphate and potash produced from public lands, in tons, by fiscal years

State	1921-1925	1926-1930	1930	1931	1921-1981
Idaho (phosphate).....	6,132.44	91,505.02	22,100.65	68,974.33	166,611.79
Nevada.....		45.45		80.72	126.17
New Mexico (potash).....				4,726.94	4,726.94
	6,132.44	91,550.47	22,100.65	73,781.99	171,464.90

Operating mines, fiscal year 1931

	Phosphate	Potash	Sodium	Coal		Total
				Shipping	Wagon	
Alaska.....				4	1	5
Alabama.....				1		1
Arizona.....			1			1
California.....			1		1	2
Colorado.....				16	63	79
Idaho.....	2				2	4
Montana.....				3	96	99
Nevada.....	1		1		1	3
New Mexico.....		1		8	11	20
North Dakota.....				7	64	71
Oregon.....				1	3	4
South Dakota.....					3	3
Utah.....				24	26	50
Washington.....				1		1
Wyoming.....				14	32	46
	3	1	3	79	303	389

Petroleum, natural gas, and natural-gas gasoline produced from public lands

1931, by States

	Petroleum (barrels)	Natural gas (cubic feet)	Gasoline (gallons)
California.....	9, 184, 952. 16	16, 994, 598, 000	66, 828, 634. 00
Colorado.....	665, 327. 80	1, 709, 179, 000	17, 916. 00
Louisiana.....	8, 918. 91	690, 591, 000	53, 346. 80
Montana.....	436, 011. 79	894, 407, 000	-----
New Mexico.....	1, 799, 815. 30	5, 791, 622, 000	672, 848. 00
Oklahoma.....	418, 063. 06	-----	899, 560. 59
Utah.....	5, 476. 69	172, 963, 000	-----
Wyoming.....	11, 322, 545. 33	15, 708, 826, 000	43, 027, 262. 00
	23, 821, 111. 33	41, 962, 184, 000	111, 499, 598. 39

Total

1921-1925.....	118, 333, 954. 01	60, 298, 796, 000	63, 997, 718. 97
1926-1930.....	128, 609, 878. 94	117, 075, 826, 640	264, 503, 664. 58
1930.....	27, 419, 509. 35	39, 124, 116, 000	101, 470, 301. 33
1931.....	23, 821, 111. 33	41, 962, 184, 000	111, 499, 598. 39
1921-1931.....	270, 764, 944. 28	219, 336, 806, 640	440, 000, 961. 94

New wells and wells shut in in major oil-producing public-land States

	Wells completed to production on public lands				Wells completed to production on all lands			
	1928	1929	1930	Jan. 1- July 1, 1931	1928	1929	1930	Jan. 1- July 1, 1931
Wyoming.....	91	91	61	12	138	134	115	28
Utah.....	6	0	4	1	10	9	13	2
Idaho.....	0	0	0	0	0	0	0	0
Colorado.....	5	4	6	2	55	35	14	10
Montana.....	21	24	19	4	283	292	125	36
New Mexico.....	11	27	24	8	19	42	169	23
California.....	50	63	32	3	688	874	752	235
	184	209	146	30	1, 193	1, 386	1, 188	318

	Wells shut in on public lands		Wells shut in on all lands		Oil and gas permits under supervision		
	July 1, 1930	July 1, 1931	July 1, 1930	July 1, 1931	Mar. 1, 1929	July 1, 1930	July 1, 1931
Wyoming.....	204	259	465	549	4, 049	1, 471	879
Utah.....	9	13	24	30	3, 014	579	510
Idaho.....	0	0	2	2	363	122	75
Colorado.....	2	6	9	15	2, 696	507	414
Montana.....	40	43	189	191	1, 672	570	493
New Mexico.....	33	39	70	124	4, 184	326	935
California.....	311	339	5, 431	7, 180	1, 453	519	444
	599	699	6, 190	8, 091	17, 431	5, 094	3, 750

NOTE.—Naval reserves and Indian lands not included.

ROYALTY, RENT, AND BONUSES

The following tables summarize accrued income from all mineral leases, licenses, and prospecting permits under the various leasing acts applicable to the public lands:

Royalties, rentals, and bonuses accrued from all mineral operations on public lands, by fiscal years

State	1912-1925	1926-1930	1930	1931	1912-1931
Alabama.....	\$26,380.00	\$32,292.60	\$13,666.10	\$12,100.20	\$130,772.80
Alaska.....	27,836.57	42,317.06	8,034.14	8,612.01	78,765.64
Arizona.....				101.50	101.50
California.....	4,676,746.55	5,294,554.92	1,034,629.91	942,994.85	10,914,905.33
Colorado.....	216,853.81	548,473.71	98,639.99	85,995.59	852,923.11
Idaho.....	1,111.38	10,872.37	2,712.97	6,480.84	18,464.56
Louisiana.....	1,508.59	35,799.11	3,583.40	5,043.47	42,356.17
Montana.....	891,278.79	847,528.76	100,988.67	72,000.01	1,810,807.56
Nevada.....	301.07	8,062.79	1,520.00	2,247.25	10,611.11
New Mexico.....	13,883.64	240,997.69	129,514.38	110,056.83	364,388.16
North Dakota.....	29,144.79	111,092.55	28,490.14	28,283.57	163,520.91
Oklahoma.....		596,553.53	105,776.14	70,335.27	666,888.80
Oregon.....	952.15	10,280.38	6,124.48	3,206.48	14,439.01
South Dakota.....	399.60	521.52	130.00	562.00	1,483.12
Utah.....	131,898.78	334,719.29	46,040.86	118,549.06	585,167.13
Washington.....	22,215.91	10,037.69	1,724.86	6,374.43	36,328.03
Wyoming.....	31,206,133.17	20,262,481.95	2,906,186.96	2,138,747.82	53,607,362.94
	37,306,644.80	28,381,595.92	4,487,763.00	3,607,396.19	69,300,131.91

Royalties, rentals, and bonuses accrued from mining operations on public lands, by States for 1931 and by fiscal years in summary

	Coal	Sodium	Phosphate	Potash	Bonuses	Total
1931						
Alabama.....	\$12,100.20					\$12,100.20
Alaska.....	8,612.01					8,612.01
Arizona.....		\$101.50		\$15,922.59		101.50
California.....	62.50					15,985.09
Colorado.....	52,540.21				\$1,000.00	53,540.21
Idaho.....	246.68		\$6,234.21			6,480.54
Montana.....	16,432.98		320.00			16,752.96
Nevada.....	7.25	2,160.00	80.00	3,838.00		2,247.25
New Mexico.....	9,040.72					12,878.72
North Dakota.....	23,249.57				34.00	23,283.57
Oregon.....	3,206.48					3,206.48
South Dakota.....	110.00				452.00	562.00
Utah.....	117,022.54				587.00	117,609.54
Wyoming.....	121,345.00				1.00	121,346.00
	370,350.52	2,261.50	6,634.21	19,760.59	2,074.00	401,080.82
SUMMARY						
1912-1925.....	776,069.09	801.07	1,111.38	24,458.65	148,384.00	950,324.19
1926-1930.....	1,609,049.71	7,200.00	10,534.05	51,776.51	4,495.00	1,683,055.27
1930.....	317,015.68	1,440.00	2,451.31	18,135.40	113.00	339,155.39
1931.....	370,350.52	2,261.50	6,634.21	19,760.59	2,074.00	401,080.82
1912-1931.....	2,755,469.32	9,762.57	18,279.64	95,995.75	164,953.00	3,034,460.28

Royalties and bonuses accrued from oil and gas operations on public lands

1931, by States

	Petroleum	Natural gas	Gasoline	Bonuses	Total
California.....	\$764,365.48	\$69,295.17	\$93,349.12		\$927,009.77
Colorado.....	28,610.61	4,529.36	15.41		33,155.38
Louisiana.....	974.16	3,371.08	106.98	\$598.25	5,068.47
Montana.....	46,078.84	3,348.19		5,820.00	55,247.03
New Mexico.....	74,717.87	21,992.47	467.77		97,178.11
Oklahoma.....	68,288.71		2,046.56		70,335.27
Utah.....	370.05	569.47			939.52
Wyoming.....	1,584,621.98	73,081.31	94,106.74	264,691.89	2,017,401.92
	2,568,027.70	177,087.05	190,092.48	271,108.14	3,206,315.37

Royalties and bonuses accrued from oil and gas operations on public lands—Con.

Total

	Petroleum	Natural gas	Gasoline	Bonuses	Total
1921-1925	\$32,938,494.47	\$308,543.30	\$251,197.70	\$2,768,065.14	\$36,306,320.61
1926-1930	24,460,387.20	501,767.49	714,943.75	935,722.21	26,702,820.65
1930	3,809,947.58	172,878.79	164,181.04	1,600.20	4,148,607.61
1931	2,568,027.70	177,087.05	190,092.48	271,108.14	3,206,315.37
1921-1931	59,966,909.87	1,167,397.84	1,156,233.98	3,974,915.49	66,265,456.68

ACTIVITIES ON NAVAL PETROLEUM RESERVES

Production from Naval Petroleum Reserve No. 3, in Wyoming, was definitely suspended December 31, 1927, and the total royalty accrued from 1923 to the date of suspension amounted to \$848,947.91. Supervision on this reserve is confined at present to periodic observation of gas pressure, inspection of repairs to the wells from time to time, and consultation with the Navy Department.

Royalties accrued from 23 oil and gas leases embracing 10,608.97 acres of land in Naval Petroleum Reserves Nos. 1 and 2 in California during the fiscal year were as follows: Petroleum, \$1,105,540.06; natural gas, \$43,307.17; gasoline, 106,809.27. The total receipts from these reserves for the fiscal years 1921 to 1931 amount to \$25,166,801.14.

Petroleum, natural gas, and gasoline produced from naval reserves

	Fiscal year	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)
California	1921-1925	37,882,945.09	35,544,349.81	34,508,751.07
	1926-1930	49,389,149.93	48,852,746.46	119,177,197.23
	1930	6,978,922.16	6,817,458.00	25,567,986.00
	1931	5,590,418.46	5,123,456.00	22,746,665.00
	1921-1931	92,862,513.48	89,520,552.27	178,434,513.30
Wyoming	1923-1925	2,523,213.05	960,520.00	7,829.00
	1926-1928	1,027,014.58	4,212,349.00	2,476,067.00
	1923-1928	3,550,227.63	5,162,869.00	2,483,896.00
Total	1921-1925	40,406,158.14	35,494,869.81	34,516,580.07
	1926-1930	50,416,164.51	53,065,095.46	121,653,264.23
	1930	6,978,922.16	6,817,458.00	25,567,986.00
	1931	5,590,418.46	5,123,456.00	22,746,665.00
	1921-1931	96,412,741.11	94,683,421.27	178,918,509.30

ACTIVITIES ON INDIAN LANDS

Cooperation with the Indian Service during the fiscal year 1931 included technical supervision of mining and drilling operations on tribal, segregated, and restricted allotted lands and on Indian lands set aside by Executive order. This work entails the enforcement of lease terms and operating regulations, the making of technical investigations of threatened impairment of mineral deposits, determinations of the adequacy of bonus offers and of threatened damage to surface improvements, appraisals of unleased property, investigations of domestic water supply contaminated by waste, and

the preparation of engineering and geologic reports on leased and unleased lands subject to mineral development. Field offices for the performance of these duties are maintained at Miami, McAlester, Muskogee, Oklahoma City, Red River, Shawnee, and Tulsa, Okla.; Billings and Shelby, Mont.; Farmington, N. Mex.; Thermopolis, Wyo.; Denver, Colo.; and Salt Lake City, Utah. Service was performed by other officers of the mineral-leasing division as required.

Oil and gas.—Supervision of oil and gas operations on behalf of the Indian Service during the fiscal year 1931 included 9,258 leaseholds on which there were 5,301 producing wells and 18 wells in process of drilling. This work was conducted at 38 different agencies in 7 States and included all Indian lands in those States except the Osage Reservation in Oklahoma. Production from Indian lands in Oklahoma resulted in royalties approximately as follows: Oil, \$2,477,000; gas, \$48,000; natural-gas gasoline, \$153,000. The total income from oil and gas is reported at \$4,173,046.89. A total of 580 field investigations and 287 reports on lease conditions resulted in increased revenue to the Indians of the western agencies in Oklahoma. Cooperation with lessees resulted in increased production and accruing royalties by the deepening and plugging back of several wells on Indian lands in Oklahoma. In western Oklahoma 658 appraisals of bonus value were made prior to lease sales.

Oil and gas leases on Indian lands in Oklahoma exclusive of the Osage Reservation

Agency	Leases			Wells		Total royalty and rentals
	Nonproducing	Producing	Total	Producing	Being drilled	
Five Civilized Tribes:						
Cherokee.....	5,367	251	6,487	5,028	10	
Choctaw.....		61				
Creek.....		532				
Chickasaw.....		20				
Seminole.....		156				
	5,367	1,120	6,487	5,028	10	\$3,364,728.95
Kiowa Indian Agency:						
Kiowa.....	232		232			
Comanche.....	285	14	299	23		
Apache.....	37	6	43	18		
Wichita.....	316		316			
Caddo.....	254		254			
	1,124	20	1,144	41		296,446.27
Pawnee Indian Agency:						
Ponca.....	102	13	115	43		
Otoe.....	167	2	169	2		
Tonkawa.....	21		21			
Pawnee.....	139	20	159	65		
Kaw.....	14	4	18	33		
	443	39	482	143		130,428.92
Shawnee Indian Agency:						
Iowa.....	25		25			
Kickapoo.....	81		81			
Pottawatomie.....	63	10	73	31		
Sac and Fox.....	122	9	131	26		
Shawnee.....	200		200			
	491	19	510	57		162,460.49
Cheyenne and Arapahoe Indian Agency:						
	383		383			101,715.04
Grand total.....	7,808	1,198	9,006	5,269	10	4,055,779.57

Outside of Oklahoma supervision was exercised over 247 oil and gas leases on Indian lands in Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming. There was no production from Arizona, Montana, and Utah during the year. A report was made on the advisability of piping natural gas to the Shiprock Agency, Northern Navajo Reservation, N. Mex.

Oil and gas leases on Indian lands outside Oklahoma

State and tribe	Leases			Wells	
	Non-producing	Producing	Total	Producing	Being drilled
Arizona:					
Navajo Executive order	14		14		
Colorado:					
Ute tribal		1	1	3	
Ute allotted					
Ceded Ute tribal	3	1	4		2
Montana:					
Blackfeet tribal	1		1		
Blackfeet allotted	39		39		1
Blackfeet Executive order					
Crow tribal	6	1	7		
Crow allotted	95	2	97		
Crow Executive order					
New Mexico:					
Navajo tribal		4	4	2	1
Navajo allotted	19		19		1
Navajo Executive order	9		9		2
Ute tribal	3	1	4	3	1
Utah:					
Navajo Executive order	6		6		
Wyoming:					
Shoshone tribal	30	1	31	4	
Shoshone allotted	3	8	11	20	
	228	19	247	32	8

Coal.—Supervision of coal-mining operations on behalf of the Indian Service in 1931 included 160 leases, 27 coal-prospecting permits, 1 coal license, and 24 agency coal mines. In Oklahoma supervision was maintained over 34 shipping mines and 17 wagon mines on 51 coal leases on segregated Choctaw-Chickasaw Indian Nation land and 57 leases on restricted allotted lands of individual Cherokee, Choctaw, and Creek Indians. From these lands was produced 389,232.69 tons of coal having a royalty value of \$34,645.86. Cooperation was maintained with the Oklahoma Geological Survey on the geologic examination of the coal resources of segregated Choctaw and Chickasaw lands, particularly in the McAlester, Wilburton, and Poteau districts. This work was begun in 1927, and the results obtained indicate that many tracts in which only one coal bed was known to exist at the time of the appraisal of 1917 in reality contain two and in places three beds.

In Colorado supervision included 42 coal leases, 1 coal license, 26 coal permits, and 9 awarded coal-lease applications on ceded Ute lands, from which \$16,952.71 in rentals and royalties accrued to the Indians. Periodic inspections and reports were made on the agency coal mines, 9 of which are in Arizona, 2 each in Colorado and Montana, 10 in New Mexico, and 1 in Utah.

Lead and zinc.—Supervision on behalf of the Indian Service of lead and zinc mining operations on restricted lands of Quapaw Indians in Ottawa County, Okla., included 39 leases, involving 5,524.43 acres, from which was produced 98,870 tons of concentrates with a sale value of \$2,694,145.86; the accrued royalty amounted to \$262,438.47. Lead and zinc were first mined on the Quapaw Reservation in 1902; in 1907 mines were opened near Commerce, and in 1914 the Pitcher field was discovered. Production has increased until it now amounts to 16.76 per cent of the lead and 28.13 per cent of the zinc output from the Tri-State district. This production equals 9.64 per cent of the zinc and 0.72 per cent of the lead mined in the United States last year. A subsale map of the northwest corner of the Quapaw Reservation and an accompanying

paper on ore-finding guides used in the Tri-State district were prepared for publication. Six nonproductive leases for lead and zinc were under supervision in Nevada, two in Montana, and one on restricted allotted Cherokee land in Oklahoma.

Miscellaneous minerals.—Inspectional and advisory service was rendered in connection with existing or proposed operations involving 2 gold, 1 iron, 5 vanadium, and 2 copper ore leases, 3 asbestos leases, and 1 miscellaneous mineral lease in Arizona; 2 sodium prospecting permits in Colorado; 1 vermiculite lease in Montana; 2 marl leases in Nevada; and 1 volcanic-ash lease in Oklahoma.

COOPERATIVE WORK

Cooperative work was continued with the Bureau of Mines in oil and gas technologic investigations; with the Bureau of Reclamation in conjunction with its lease on the power plant and coal mine at Williston, N. Dak.; with the National Research Council on the conservation of scientific data obtained as the result of drilling and the improvement of drilling methods and equipment; with the Oklahoma State Geological Survey in the study and preparation for publication of geologic data relative to the coal resources of the segregated lands of the Choctaw and Chickasaw Nations, Oklahoma; and with the American Institute of Mining and Metallurgical Engineers on methods of coal-land valuation.

The chief mining supervisor, as a representative of the Interior Department, attended the World Power Conference in Berlin, Germany, in the summer of 1930 and later investigated methods of open-pit mining of coal in parts of Europe, zinc and lead mining in Poland, and potash mining in France, Poland, and Germany.

COST OF SUPERVISION

Preliminary estimates indicate that the cost of supervisory work on public and Indian lands during the fiscal year 1931 averaged less than 4.36 per cent of the aggregate income from the leases, licenses, and permits in effect on these lands. This is an increase of 1.3 per cent over the supervisory cost of the preceding year; the increase is chargeable principally to the decline in value of the minerals produced.

WORK ON PUBLICATIONS

TEXTS

BERNARD H. LANE, *Editor*

During the year 24,701 pages of manuscript were edited and prepared for printing by the section of texts, and 3,758 galley proofs and 14,420 page proofs were read and corrected. Indexes were prepared for 52 publications, covering 8,089 pages. Copy and proof or stencils for 1,418 pages of multigraph and mimeograph matter were read. At the end of the year five persons were employed in this section. The publications issued during the year are listed on pages 4, 5.

The editor has continued to serve as a member of the departmental subcommittee to assist in the revision of the Style Manual of the Government Printing Office.

ILLUSTRATIONS

C. A. WECKERLY, Chief Illustrator

The number of drawings and photographs prepared by the section of illustrations was 3,839, including 111 maps, 1,309 sections and diagrams, 3 plates of sections, 79 charts and plans, 815 photographs, 1,517 paleontologic drawings, and 5 wash drawings; 154 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany 31 reports numbered 1,033, to be reproduced by chromolithography, photolithography, halftone, and zinc etching. The number of proofs received and examined was 887. At the end of the year material for illustrating 17 reports was in hand. The section consists of nine employees.

GEOLOGIC EDITING AND DRAFTING OF MAPS AND ILLUSTRATIONS

GEORGE W. STOSE, Editor of Geologic Maps

The geologic maps and sections of the Gaffney-Kings Mountain (S. C., N. C.) folio were approved for printing. The geologic maps of the Coatesville-West Chester (Pa.) folio reached the stage of color proof, and the sections were transferred to stone ready for color proof. The geologic maps and sections of the Somerset-Windber (Pa.) folio were transferred to stone ready for color proof. The geologic maps of the Montevallo-Columbiana (Ala.) folio were made ready for transfer to stone, and the sections were sent for engraving. No progress was made on the Hollidaysburg-Huntingdon (Pa.) folio. The Boston folio was withdrawn and submitted for publication as a bulletin.

Topographic and mineral industry maps of Arkansas were published for the Arkansas Geological Survey. A block diagram of the Tonopah mining district, Nevada, was published for the Nevada Bureau of Mines in cooperation with the United States Geological Survey. Stone proof of the geologic map of Pennsylvania on a scale of 1:500,000, prepared for the Pennsylvania Geological Survey, was read. The preliminary draft of the geologic map of California on a scale of 1:500,000, for the California Division of Mines, was nearly completed. The compilation of the geologic map of Texas on a scale of 1:500,000 was well advanced. Preliminary geologic maps of Oregon and Colorado and of parts of Georgia, North Carolina, South Carolina, Alabama, Virginia, and Montana on a scale of 1:500,000 were compiled by this section and other members of the Geological Survey for use on the geologic map of the United States. Two parts of the geologic map of the United States on a scale of 1:2,500,000 were completed and sent for engraving, and progress was made on most of the rest of the map.

Illustrations for 24 reports were examined and edited for the section of illustrations, and other geologic and drafting assistance was rendered to that section. In addition, 24 illustrations for 15 reports were drawn for geologists. The oil and gas maps of the United States, California, Wyoming, and Illinois were compiled and drawn

for photolithography, and the drawing of the oil map of Texas was revised. Two new draftsmen were assigned to the section, which now consists of six employees.

INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

W. M. BEAMAN, Chief

During the year 101 new topographic maps were edited and transmitted for engraving, 231 published topographic maps, 6 State maps, and 7 State index circulars were edited for reprint, and 287 maps were edited as illustrations for Geological Survey reports—a total of 632 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 425 and proofs of maps reproduced by photolithography in one to three colors numbering 230 were read. At the end of the year 210 new topographic maps were in progress of engraving and printing and 181 new topographic maps were in preparation for submission for reproduction. The topographic maps published during the year are listed on pages 5-7.

DISTRIBUTION

R. C. SHELSE, Chief

A total of 317 publications, comprising 47 new books and pamphlets, 78 new or revised topographic and other maps, and 192 reprinted topographic and other maps, were received by the division of distribution during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 109,574 books and pamphlets and 712,570 topographic and other maps, a grand total of 822,144.

The division distributed 116,298 books and pamphlets, 4,282 geologic folios, and 776,851 maps, a grand total of 897,431, of which 4,009 folios and 651,907 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$42,788.68, including \$41,756.71 for topographic and geologic maps and \$1,031.97 for geologic folios. In addition to this \$1,648.70 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$44,437.38.

The division received and answered 49,973 letters.

ENGRAVING AND PRINTING

S. J. KUBEL, Chief Engraver

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the fiscal year 74 new topographic maps were engraved and printed, including two revised maps. Four new maps were photolithographed and printed, making a total of 78 new maps printed and delivered. One fractional sheet for La Crosse County, Wis., and the United States 2-sheet map were engraved but not printed. Corrections were engraved on the plates of 229 maps. Re-

print editions of 184 engraved topographic maps and 8 photolithographed State and other maps were printed and delivered. In addition, 68 new topographic maps had been engraved and were in press June 30, and the engraving of 38 other new topographic maps was nearly completed. Of new and reprinted maps, 270 different editions, amounting to 712,570 copies, were delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, the office of the Secretary of the Interior, the Bureau of Reclamation, Office of Education, General Land Office, National Park Service, Indian Service, Alaska Railroad, Forest Service, Plant Quarantine and Control Administration, Bureau of Public Roads, Weather Bureau, Bureau of Agricultural Economics, Bureau of Plant Industry, Bureau of Biological Survey, Bureau of Entomology, Bureau of Mines, Bureau of Lighthouses, Bureau of Foreign and Domestic Commerce, Aeronautics Branch, Federal Radio Commission, Bureau of Standards, Federal Farm Loan Bureau, United States Marine Corps, Hydrographic Office, Department of State, War Department, Post Office Department, Department of Agriculture, Department of Commerce, Department of Labor, Department of Justice, Interstate Commerce Commission, National Capital Park and Planning Commission, Commission of Fine Arts, Federal Power Commission, New Mexico-Texas Boundary Commission, Alaska Road Commission, International Boundary Commission, George Washington Bicentennial Commission, Office of the Chief Signal Officer, Office of the Chief of Engineers, Engineer Map Reproduction Plant, Coast Artillery School, Engineer School, General Staff School, Panama Canal, Federal Farm Board, Federal Board for Vocational Education, United States Veterans Bureau, International and Overseas Exposition, Regional Planning Federation of the Philadelphia Tri-State District, Public Buildings and Public Parks, Sanitary District of Decatur, Ill., and the States of Nevada, Arkansas, Missouri, Kentucky, Louisiana, and Wisconsin. This work, done for the other branches of the Government and State governments, included many reprints, and the charges for it amounted to about \$146,500, for which the appropriation for engraving and printing geologic and topographic maps was reimbursed.

Transfer impressions numbering 365 were made during the year, including 168 furnished to contracting lithographic printers on requisition of the Government Printing Office, 18 furnished to other branches of the Government, 21 furnished to State surveys, and 158 furnished to private firms. The amount turned over to miscellaneous receipts was \$520.43.

Of contract and miscellaneous work of all kinds, 2,794,964 copies were printed. Including topographic maps a grand total of 3,507,534 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 15,088 negatives (4,863 wet (of which 3,658 were for photolithographs), 65 paper, 2,196 dry, 7,278 field negatives, and 686 lantern slides), 35,820 prints (4,443 maps and diagrams and 31,377 photographs for illustrations), 3,236 zinc plates, 294 zinc etchings, 33 celluloid prints, 217 lantern slides colored, 29 transparencies colored, 3 prints colored, and 2,916 prints mounted.

ADMINISTRATION

JULIAN D. SEARS, Administrative Geologist

JOHN J. MADIGAN, Chief Clerk

The administrative geologist assists the director in all phases of general administration, performs special tasks assigned to him by the director from time to time, serves as acting director in the director's absence, and has special supervision over the section of illustrations.

The chief clerk, in addition to performing the duties usually pertaining to that office, serves as budget officer and exercises administrative supervision over the division of engraving and printing, the division of distribution, the section of correspondence and records, the section of accounts, the library, and the division of field equipment.

CORRESPONDENCE AND RECORDS

C. A. KING, Chief

The work of the section of correspondence and records was of the same general character as during the fiscal year 1930.

Mails, files, and records.—During the year 97,834 pieces of mail, of which 2,125 were registered, were opened and referred. In addition, 149,068 letters were received direct by the other units, making a total of 246,902, an increase of 7 per cent compared with 1930. Of the letters opened in this section 18,863 contained \$43,104.30 remitted for Geological Survey publications. The number of ordinary letters mailed through the section was 57,878; of registered letters and packages, 1,212. In addition, 152,170 pieces of mail were sent out direct from other units. The total number of outgoing pieces of mail for the Geological Survey was 211,260.

Freight and express.—During the year 3,255 pieces of freight and express were handled, 1,689 outgoing and 1,566 incoming.

Personnel.—The roll of Secretary's appointees numbered 1,127 at the end of the fiscal year, 62 more than at the end of 1930. The total number of changes in personnel was 1,110, including 139 appointments, 77 separations, and 894 miscellaneous changes.

During the calendar year 1930, 20,324 days of annual leave and 3,667 days of sick leave were granted, being 71 per cent of the amount of annual leave that could have been taken and 12 per cent of the sick leave that it would have been possible to grant. In addition, 8,383 days of leave without pay and furloughs were also granted.

ACCOUNTS

C. K. FRANCIS, Chief

During the year 20,312 field accounts, 1,793 transportation bills, and 216 telegraph bills were audited and transmitted for payment. In the audit of these accounts 1,039 suspensions and disallowances were made. The section received 262 printing and binding requisitions, 879 stationery requisitions, 3,095 miscellaneous supply requisitions, 2,714 letters of employment, and 375 contracts.

Condensed statements covering expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

Amounts appropriated for, transferred to, and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1931.

	Funds available			Expenditures			Balance	
	Amount of appropriation	Repayments on account of work performed		Total	Disbursements	Outstanding liabilities		Total
		Made	To be made					
APPROPRIATIONS								
Salaries.....	\$141,320.00	\$245.00		\$141,565.00	\$140,721.96		\$843.04	
Topographic surveys.....	744,000.00	281,723.44	\$59,625.30	1,085,358.74	940,780.59	\$11,813.97	132,764.18	
Shenandoah and Great Smoky Mountains National Parks.....	75,000.00	3.57		75,003.57	63,346.79	8,888.61	2,768.17	
Geologic surveys.....	400,000.00	39,891.23	11,573.31	431,464.54	426,323.31	19,255.11	5,886.12	
Fundamental research in geologic science.....	100,000.00	241.78		100,241.78	98,593.67	735.40	99,329.07	
Volcanologic surveys.....	21,000.00		7.50	21,007.50	18,897.42	2,101.94	20,969.36	
Alaskan mineral resources.....	75,000.00	316.90		75,316.90	60,802.43	14,446.31	38.14	
Gaging streams.....	510,000.00	206,445.33	76,179.51	792,624.84	752,368.55	14,238.29	68.16	
Classification of lands.....	180,480.00	823.35		181,303.35	178,405.11	2,215.08	766,606.84	
Printing and binding.....	150,000.00	36.44		150,036.44	118,751.72	118,751.72	180,620.73	
Preparation of illustrations.....	20,800.00	631.76		21,431.76	21,418.77	8.96	21,427.73	
Geologic and topographic maps.....	125,000.00	124,377.27	21,400.12	270,837.39	259,526.35	10,033.87	269,560.22	
Mineral leasing.....	251,820.00	501.92	1,187.13	253,509.05	244,140.03	9,369.02	253,509.05	
U. S. Geological Survey, 1931 (Alaskan mineral resources).....	200.00			300.00	300.00		300.00	
U. S. Geological Survey, 1930-31 (Mammoth Cave National Park).....	25,090.00	5.75		25,095.75	22,765.59	2,240.16	25,005.75	
U. S. Geological Survey, 1930-31 (plugging wells).....	43,190.75		344.17	43,534.92	16,071.89	27,446.00	18.03	
Great Smoky Mountains National Park in North Carolina and Tennessee, 1929-30 (available for 1931).....	7,020.10			7,020.10	7,020.10		7,020.10	
	\$2,869,990.85	\$655,273.74	170,317.04	3,695,581.63	3,282,737.28	241,544.04	3,524,281.32	
TRANSFERS								
Acquisition of lands for protection of watersheds of navigable streams (Agriculture Department, act May 14, 1930), 1931.....	276.04			276.04	276.04		276.04	
Alaska Railroad fund (act May 14, 1930).....	30,000.00		98.70	30,098.70	13,617.16	14,804.58	28,421.74	
Ammunition storage facilities, Navy (Navy Department, act May 14, 1930).....	1,000.00			1,000.00	501.94	434.08	936.02	
Aviation, Navy (Navy Department, act May 14, 1930), 1931.....	13,900.00			13,900.00	11,716.30	1,588.42	13,304.72	
Cheyenne Bottoms Migratory Bird Refuge (Agriculture Department, act May 14, 1930), 1931.....	600.00			600.00	261.05	328.42	589.47	
Federal Power Commission (act May 14, 1930), 1931.....	6,075.00			6,075.00	5,150.61	318.33	5,468.94	
Flood control, Mississippi River and tributaries (War Department, act May 14, 1930).....	275,122.00	2,140.92	17.06	277,288.98	201,481.94	20,532.00	222,014.03	
Fredericksburg and Spotsylvania County Battle Fields Memorial, Virginia (War Department, act May 14, 1930), 1931-32.....	5,000.00			5,000.00	3,770.01	65.56	3,844.57	
							1,155.43	

Investigating potash deposits, Bureau of Mines (Commerce Department, act Apr. 18, 1930), 1931.	12,500.00				12,500.00	11,788.64	633.91	12,422.55	77.45
Irrigation, Indian reservations (reimbursable), 1930-31 (act May 14, 1930).	600.00				600.00	187.56	117.56	305.12	294.88
Maintenance and improvement of existing river and harbor works (War Department, act May 14, 1930).	220,111.00	806.47	16.81		220,924.28	186,806.77	13,356.76	200,163.83	20,770.76
Military surveys and maps (War Department, act May 14, 1930), 1930-Dec. 31, 1931.	6,000.00				6,000.00	5,449.48	110.72	5,560.20	439.80
National Park Service (act May 14, 1930), 1930-31.	500.00	254.19			754.19	754.19		754.19	
National Park Service, donations (act May 14, 1930).	5,000.00				5,000.00	4,479.37	272.20	4,751.57	248.43
Operation and conservation of naval petroleum reserves (Navy Department, act May 14, 1930), 1931.	2,000.00	.75			2,000.75	1,999.98		1,999.98	.77
Supervising mining operations on leased Indian lands (act May 14, 1930), 1931.	45,000.00				45,000.00	44,796.36	43.10	44,839.46	160.54
Support of United States prisoners (Justice Department, act May 14, 1930), 1931.	85,000.00	446.40	38.89		85,485.29	84,148.16	1,337.13	85,485.29	
United States Northeastern Penitentiary (Justice Department, act May 21, 1929).	2,500.00				2,500.00	1,341.34		1,341.34	1,158.66
United States Southwestern Reformatory (Justice Department, act May 21, 1929).	2,174.34				2,174.34	2,174.34		2,174.34	
United States Yorktown Bicentennial Commission (act May 14, 1930), 1931.	2,500.00				2,500.00	1,096.02	456.19	1,552.21	947.79
Water boundary, United States and Mexico (State Department, act Apr. 18, 1930), 1931.	4,500.00	60.01			4,560.01	4,560.01		4,560.01	
Waterways treaty, United States and Great Britain (State Department, act Apr. 18, 1930), 1931.	18,440.00	28.08			18,468.08	17,131.86	1,256.42	18,388.28	77.80
Grand total.	67,940.00	441.66	1.31		68,062.97	65,804.78	953.48	66,758.26	1,324.71
	3,676,426.23	659,450.23	170,469.81		4,506,378.26	3,962,040.19	298,163.59	4,260,193.78	259,184.48

* In addition to these appropriations, there was an allotment of \$13,013.75 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

† Of this amount, \$68,513.18 has been expended for the purposes shown below, as provided for in the second deficiency act, 1931:

Gaging streams.	942,405.49
Mineral leasing.	18,174.04
Supervising mining operations on leased Indian lands.	4,013.67
Mammoth Cave National Park.	2,919.98

* Balance represents estimated cost of printing cooperative reports, the charge for which will be made against the appropriation for printing and binding in a subsequent year.

† Includes the following amounts appropriated for salary increases by the Second Deficiency Act, 1931:

Salaries.	68,513.18
Alaskan mineral resources.	\$1,320
Classification of lands.	300
Geologic and topographic maps.	490
Mineral leasing.	1,060
	1,890

* Included in this amount is \$54,332.14 covering work performed by Geological Survey units for other Geological Survey units, necessarily reported in combining totals but otherwise a duplication.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1931

Object of expenditure	Geological Survey salaries	Topographic surveys and national parks	Geologic surveys	Volcanologic surveys	Alaskan mineral resources	Gaging streams	Classification of lands	Geologic and topographic maps of the United States	Preparation of illustrations	Mineral leasing	Fundamental research	Printing and binding	Total
Personal services.....	\$140,721.06	\$891,159.14	\$356,368.68	\$17,784.50	\$93,170.50	\$828,642.30	\$151,292.77	\$212,064.04	\$20,666.92	\$314,010.22	\$87,897.78	---	\$3,078,768.81
Stationery and office supplies.....	---	4,065.54	1,687.96	238.49	317.88	5,628.16	106.06	23,849.02	108.94	2,260.07	26.01	---	83,332.13
Scientific and educational supplies.....	---	309.14	1,483.38	23.90	29.40	590.88	63.97	---	---	429.42	3.23	---	2,903.32
Sundry supplies.....	---	2,344.62	1,995.23	161.66	578.18	3,043.46	168.62	6,440.61	57.26	750.16	38.07	---	14,574.90
Substance and care of animals and storage and care of radioes.....	---	2,376.41	432.60	---	443.20	---	291.85	---	---	---	---	---	2,534.75
Telephone service.....	---	662.24	294.19	---	62.61	730.50	47.89	6.88	99	868.86	6.00	---	2,644.55
Other communication service.....	---	217.27	161.96	26.06	6.80	2,060.50	7.54	---	---	2,660.13	6.20	---	6,116.49
Travel expenses.....	---	13.90	3.60	43	---	37.07	---	---	---	76.61	---	---	6,181.13
Attendance at meetings.....	---	126,294.63	38,143.74	1,413.97	24,544.12	84,621.62	13,935.66	104.20	---	22,213.77	6,316.19	---	314,446.79
Hire, maintenance, operation, repair of horse-drawn and motor-propelled passenger-carrying vehicles.....	---	65.14	2,178.91	---	65.00	1,247.89	---	---	---	330.72	---	---	3,887.66
Transportation of things.....	---	2,620.94	5,316.34	250.66	---	33,314.45	4,893.77	---	---	21,474.63	718.21	---	68,583.08
Printing and binding.....	---	58,240.96	8,658.75	391.02	3,961.91	27,002.61	3,456.70	38.02	2.51	2,388.16	1,155.85	---	105,323.49
Lithographing, engraving, and etching.....	---	---	---	---	---	---	---	---	---	---	---	\$150,086.44	150,086.44
Stenographic work, typewriting, and duplicating work, etc. (job work).....	---	15,618.75	1,007.56	---	---	768.16	1,608.65	161.70	282.81	102.22	---	---	19,639.85
Photographing and making photographs and prints.....	---	22.55	2.60	---	---	56.60	1.00	---	---	40.00	---	---	125.65
Heat, light, power, water, and electricity.....	---	49,654.20	4,889.89	186.41	330.26	3,689.44	906.42	---	245.50	518.50	1,867.97	---	62,287.59
Repairs and alterations.....	---	467.33	71.55	72.37	50.16	313.85	---	---	---	4,031.82	---	---	4,544.76
Special and miscellaneous current expenses.....	---	276.03	553.60	294.49	225.29	5,466.94	---	---	---	8,218.44	---	---	14,183.61
Purchase of passenger-carrying vehicles.....	---	555.89	373.95	---	---	4,368.04	2.06	2,283.30	2.50	46,274.94	6.10	---	53,260.35
Furniture, furnishings, and fixtures.....	---	2,247.65	3,506.82	---	---	510.00	25.66	---	---	292.64	10.00	---	2,315.66
---	---	1,976.04	1,452.07	55.70	3,474.63	8,416.96	3,064.00	---	---	11,925.18	514.38	---	26,664.01
---	---	---	---	---	---	7,571.59	239.10	50.00	---	3,778.89	---	---	18,598.02

LIBRARY

GUY E. MITCHELL, *Librarian*

During the year more than 500 Government publications, paper bound or in dilapidated covers, have been replaced on the shelves by good bound copies in the original binding.

Binding allotments, fiscal years 1928-1931, and number of books bound

Fiscal year	Allotment for year	Cost	Number of books bound	Fiscal year	Allotment for year	Cost	Number of books bound
1928.....	\$5,000	\$4,205	1,800	1930.....	\$4,500	\$4,454	1,305
1929.....	2,500	3,506	1,100	1931.....	3,500	3,079	1,163

During the last year the library has had a substantially increased allotment for the purchase of new books and periodicals. This increase has been of material assistance in making needed book purchases.

Allotments and expenditures for new books and periodicals, 1928-1931

Fiscal year	Allotment	Expenditures	Fiscal year	Allotment	Expenditures
1928.....	\$2,000	\$1,198	1930.....	\$2,000	\$1,996
1929.....	2,000	1,997	1931.....	2,500	2,463

Not all of these expenditures are for the library itself. About 25 per cent of the money is used for periodicals for field offices and "working tools" for the office and field—dictionaries, atlases, etc.

During the year the cumulated bibliography of North American geology for 1919-1928 (Bulletin 823) was printed and delivered. The bibliography for 1929 and 1930 (Bulletin 834) was completed and sent to the printer, and work was in progress on the bibliography for 1931 and 1932.

The Geological Survey library cooperated with other important libraries of the country in checking two serial lists, whose purpose is to show the libraries throughout the United States and Canada where the publications listed may be found. One of these was the "List of serial publications of foreign governments," Sections V and VI, including the countries of Austria, Germany, Czechoslovakia, Hungary, Poland, the Balkan states, France and French possessions, Great Britain, and Ireland and British possessions in Europe. For this list 428 titles were examined, of which 319 were compared with the records and holdings reported; and 15 new titles not on the list were added, making a total of 334 titles reported. The other was the "Union list of serials, supplement, 1926-1930," which was checked throughout the alphabet. This supplement is designed to bring the large list of 1925 down to the end of 1930 and include all general serials exclusive of Government publications. For this work 751 titles were examined for holdings, changes of holdings, or discontinuance, and 228 were compared with the records and reported.

The accessions during the year comprised 13,180 books, pamphlets, and periodicals and 900 maps. The readers and users of books and maps in the library numbered 8,132, of whom 2,874 were not members of the Geological Survey. The loans for use outside the library included 5,817 books and 222 maps. In the work of cataloging 7,714 cards were added to the catalog, 1,203 catalog cards were revised, 433 titles were sent to the Library of Congress for printing, and 125 galley proofs were read. The books collated and sent to the bindery numbered 1,163, and 676 newly bound books were recorded and labeled. Translations of 76 communications were made for other divisions of the Geological Survey.

FIELD EQUIPMENT

R. L. ATKINSON, Chief

The instrument shop designed and constructed a temperature apparatus, precise tool-steel measuring wheels, steel weirs, a gage for meter parts, a testing apparatus for meters, an apparatus for measuring the power, pupil, and effective aperture of telescopes, an airplane-camera mount, ground rods for electric apparatus, high-pressure bombs, and depth bombs; made an apparatus for measuring water flow and 2,607 miscellaneous pieces of equipment; repaired and rebuilt 2,936 instruments of different kinds; and did work for the Corps of Engineers, Bureau of Agricultural Economics, Weather Bureau, National Park Service, Bureau of Mines, Bureau of Reclamation, Indian Service, and Forest Service.

The cabinet shop constructed a paper jogger for offset press, a large sectional frame for exhibits, sensitizing tubs and cradles for the photographic laboratory, 45 special cases for apparatus of different kinds, 2 shadowgraphs, 60 stadia rods, 23 precise rods, 36 plane-table boards, 8 compass beams, 2 tables, and 2 special benches, besides the routine cabinet work.

The electrical shop designed and installed lighting and ventilation on line-up machine, wired 2 shadowgraphs, redesigned electric drive on plate-whirling machine, changed signal system on multi-color press, installed control panels on temperature apparatus, and made monthly inspection and repairs of 78 electric motors, electric heaters, and temperature apparatus.

The clerical force filled 2,653 requisitions for instruments, issued 26,511 pieces of equipment, mailed 3,975 packages, shipped 1,698 pieces of express and freight weighing 112,646 pounds, and received 1,566 pieces of express and freight weighing 116,249 pounds.

Overtime amounting to 1,614 hours was reported by 17 employees.

W. C. MENDENHALL,
Acting Director.



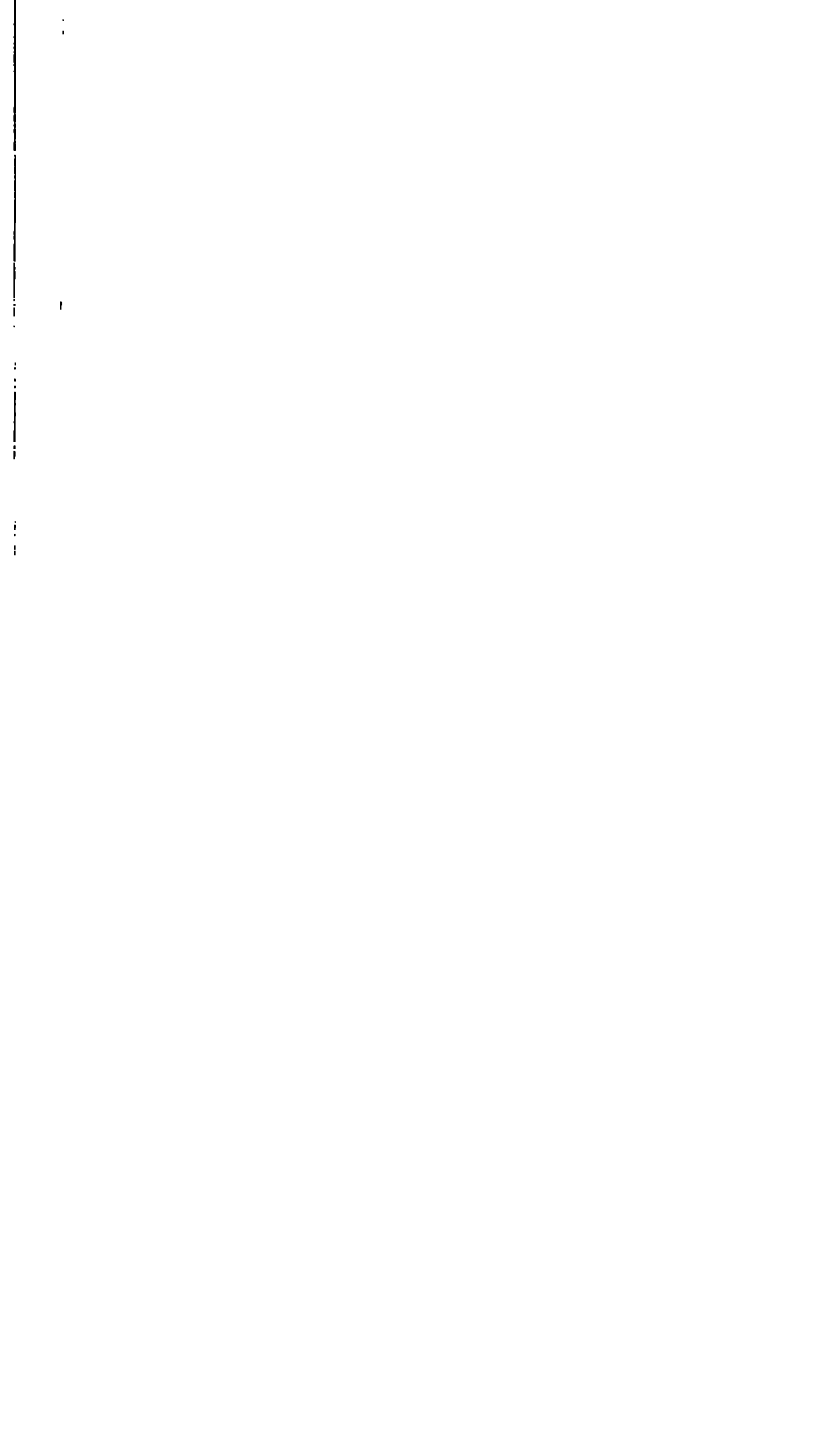
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UNITED STATES DEPARTMENT OF THE INTERIOR

*ANNUAL REPORT OF THE
DIRECTOR OF
THE GEOLOGICAL SURVEY
TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1932*



UNITED STATES DEPARTMENT OF THE INTERIOR

RAY LYMAN WILBUR, Secretary

GEOLOGICAL SURVEY

WALTER CURRAN MENDENHALL, Director

FIFTY-THIRD ANNUAL REPORT

OF THE

**DIRECTOR OF
THE GEOLOGICAL SURVEY**

TO THE

SECRETARY OF THE INTERIOR

FOR THE

FISCAL YEAR ENDED JUNE 30, 1932



UNITED STATES

GOVERNMENT PRINTING OFFICE

WASHINGTON : 1932

Directors of the Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907

GEORGE OTIS SMITH, 1907-1936

WALTER CURRAN MENDENHALL, 1931-

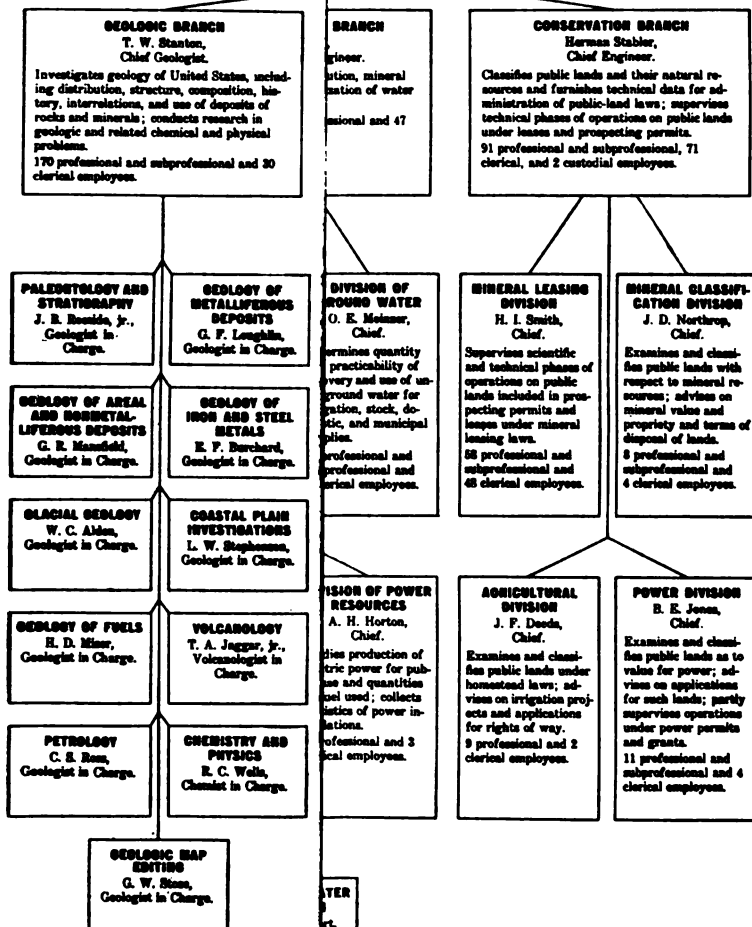
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ANNUAL REPORT
OF THE
DIRECTOR OF THE GEOLOGICAL SURVEY

W. C. MENDENHALL, *Director*

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 15, 1932.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1932 included 12 items, amounting to \$3,141,740. In addition \$12,573.23 for miscellaneous supplies was allotted from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of the report. The balance on July 31 was \$206,411.98, of which \$150,000 continued available for expenditure in the fiscal year 1933.

The total amount of funds made available for disbursement by the Geological Survey, together with State funds directly disbursed for work administered by the Federal officials, was \$5,115,087.50.

PUBLICATIONS OF THE YEAR

The following publications were issued during the fiscal year 1932:

ANNUAL REPORT

Fifty-second Annual Report of the Director of the Geological Survey.

PROFESSIONAL PAPERS

162. Geology and ore deposits of the Goodsprings quadrangle, Nev., by D. F. Hewett.
163. The significance of geologic conditions in Naval Petroleum Reserve No. 3, Wyo., by W. T. Thom, jr., and E. M. Spieker, with a section on the waters of the Salt Creek-Teapot Dome uplift, by Herman Stabler.
164. The Kaiparowits region, a geographic and geologic reconnaissance of parts of Utah and Arizona, by H. E. Gregory and R. C. Moore.
165. Shorter contributions to general geology, 1930; W. C. Mendenhall, chief geologist.
- 165-C. Geology of the eastern part of the Santa Monica Mountains, Los Angeles County, Calif., by H. W. Hoots.
168. Origin and microfossils of the oil shale of the Green River formation of Colorado and Utah, by W. H. Bradley.
169. Geology and ore deposits of the Bonanza mining district, Colorado, by W. S. Burbank, with a section on history and production, by C. W. Henderson.
- 170-A. Glaciation in Alaska, by S. R. Capps.

- 170-B. The Upper Cretaceous ammonite genus *Barroisiceras* in the United States, by J. B. Reeside, jr.
 170-C. A Miocene flora from Grand Coulee, Wash., by E. W. Berry.
 170-D. Pliocene fossils from limestone in southern Florida, by W. C. Mansfield.
 172. Gold quartz veins of the Allegheny district, Calif., by H. G. Ferguson and R. W. Gannett.

BULLETINS

818. Geology and mineral resources of the Cleveland district, Ohio, by H. P. Cushing, Frank Leverett, and F. R. Van Horn.
 824. Mineral resources of Alaska, report on progress of investigations in 1929, by P. S. Smith and others.
 824-B. The Slana district, upper Copper River region, Alaska, by F. H. Moffit.
 824-C. The Lake Clark-Mulchatna region, Alaska, by S. R. Capps.
 824-D. Mining in the Circle district, Alaska, by J. B. Mertie, jr.
 824-E. The occurrence of gypsum at Iyoukeen Cove, Chichagof Island, Alaska, by B. D. Stewart.
 827. A geologic reconnaissance of the Dennison Fork district, Alaska, by J. B. Mertie, jr.
 828. Geology and mineral resources of the Quakertown-Doylestown district, Pennsylvania and New Jersey, by F. Bascom, E. T. Wherry, G. W. Stose, and A. I. Jonas.
 829. Geology and coal, oil, and gas resources of the New Kensington quadrangle, Pennsylvania, by G. B. Richardson.
 830-A. Copper deposits near Keating, Oreg., by James Gilluly.
 831-A. The Jackson gas field, Hinds and Rankin Counties, Miss., by W. H. Monroe.
 832. The crystal cavities of the New Jersey zeolite region, by W. T. Schaller.
 833. Mineralogy of drill cores from the potash field of New Mexico and Texas, by W. T. Schaller and E. P. Henderson.
 834. Bibliography of North American geology, 1929 and 1930, by J. M. Nickles.
 836-A. Mineral industry of Alaska in 1930 and Administrative report, by P. S. Smith.
 836-B. Notes on the geography and geology of Lituya Bay, Alaska, by J. B. Mertie, jr.
 836-C. Surface water supply of southeastern Alaska, 1909-1930, by F. F. Henshaw.
 838. Nitrate deposits of the United States, by G. R. Mansfield and Leona Boardman.

WATER-SUPPLY PAPERS

637. Contributions to the hydrology of the United States, 1930; N. C. Grover, chief hydraulic engineer.
 637-D. Geology and water resources of the middle Deschutes River Basin, Oregon, by H. T. Stearns.
 638-A. A preliminary report on the artesian water supply of Memphis, Tenn., by F. G. Wells.
 638-B. Water-power resources of the Rogue River drainage basin, Oregon, by B. E. Jones, Warren Oakey, and H. T. Stearns.
 638-C. Outline of methods for estimating ground-water supplies, by O. E. Meinzer.
 638-D. Quality of water of the Colorado River in 1928-1930, by C. S. Howard.

Papers on surface water supply of the United States as follows:

642. 1927, Part 2, South Atlantic slope and eastern Gulf of Mexico basins.
 651. 1927, Part 11, Pacific slope basins in California.
 652. 1927, Part 12, North Pacific slope drainage basins: A, Pacific slope basins in Washington and upper Columbia River Basin.
 653. 1927, Part 12, North Pacific slope drainage basins: B, Snake River Basin.
 654. 1927, Part 12, North Pacific slope drainage basins: C, Pacific slope basins in Oregon and lower Columbia River Basin.
 661. 1928, Part 1, North Atlantic slope drainage basins.
 662. 1928, Part 2, South Atlantic slope and eastern Gulf of Mexico basins.
 663. 1928, Part 3, Ohio River basin.
 664. 1928, Part 4, St. Lawrence River Basin.

665. 1928, Part 5, Hudson Bay and upper Mississippi River Basins.
 666. 1928, Part 6, Missouri River Basin.
 667. 1928, Part 7, Lower Mississippi River Basin.
 668. 1928, Part 8, Western Gulf of Mexico basins.
 669. 1928, Part 9, Colorado River Basin.
 670. 1928, Part 10, The Great Basin.
 671. 1928, Part 11, Pacific slope basins in California.
 672. 1928, Part 12, North Pacific slope drainage basins: A, Pacific slope basins in Washington and upper Columbia River Basin.
 673. 1928, Part 12, North Pacific slope drainage basins: B, Snake River Basin.
 674. 1928, Part 12, North Pacific slope drainage basins: C, Pacific slope basins in Oregon and lower Columbia River Basin.
 675. Hawaii, July 1, 1927, to June 30, 1928.
 681. 1929, Part 1, North Atlantic slope drainage basins.
 682. 1929, Part 2, South Atlantic slope and eastern Gulf of Mexico basins.
 683. 1929, Part 3, Ohio River Basin.
 684. 1929, Part 4, St. Lawrence River Basin.
 685. 1929, Part 5, Hudson Bay and upper Mississippi River basins.
 686. 1929, Part 6, Missouri River Basin.
 687. 1929, Part 7, Lower Mississippi River Basin.
 688. 1929, Part 8, Western Gulf of Mexico basins.
 689. 1929, Part 9, Colorado River Basin.
 690. 1929, Part 10, The Great Basin.
 691. 1929, Part 11, Pacific slope basins in California.
 692. 1929, Part 12, North Pacific slope drainage basins: A, Pacific slope basins in Washington and upper Columbia River Basin.
 693. 1929, Part 12, North Pacific slope drainage basins: B, Snake River Basin.
 694. 1929, Part 12, North Pacific slope drainage basins: C, Pacific slope basins in Oregon and lower Columbia River Basin.
 696. 1930, Part 1, North Atlantic slope drainage basins.
 699. 1930, Part 4, St. Lawrence River Basin.
 701. 1930, Part 6, Missouri River Basin.
 702. 1930, Part 7, Lower Mississippi River Basin.
 703. 1930, Part 8, Western Gulf of Mexico basins.
 704. 1930, Part 9, Colorado River Basin.
 705. 1930, Part 10, The Great Basin.
 706. 1930, Part 11, Pacific slope basins in California.
 707. 1930, Part 12, North Pacific slope drainage basins: A, Pacific slope basins in Washington and upper Columbia River Basin.
 708. 1930, Part 12, North Pacific slope drainage basins: B, Snake River Basin.

GEOLOGIC FOLIO

222. Gaffney-Kings Mountain, S. C.-N. C., by Arthur Keith and D. B. Sterrett.

TOPOGRAPHIC AND OTHER MAPS

[The figures in parentheses indicate limiting parallels and meridians of the areas covered]

Alabama:

Eutaw (32° 45'-33°; 87° 45'-88°).

Alaska:

Lower Matanuska Valley (61° 39'-61° 53'; 147° 55'-149° 10').

Alaska, scale 1 inch=39.5 miles.

California:

Arroyo Sequit (34°-34° 6'; 118° 54'-119°).

Buttonwillow (35° 22' 30''-35° 30'; 119° 22' 30''-119° 30').

Deepwell Ranch (35° 37' 30''-35° 45'; 119°-119° 7' 30'').

Delta Farms (36° 15'-36° 22' 30''; 120° 7' 30''-120° 15').

East Elk Hills (35° 15'-35° 22' 30''; 119° 22' 30''-119° 30').

Edison (35° 15'-35° 22' 30''; 118° 45'-118° 52' 30'').

Goose Lake (35° 30'-35° 37' 30''; 119° 30'-119° 37' 30'').

Gosford (35° 15'-35° 22' 30''; 119°-119° 7' 30'').

Humphreys (34° 24'-34° 30'; 118° 24'-118° 30').

Las Flores (34°-34° 6'; 118° 36'-118° 42').

Mouth of Cantua Creek (36° 22' 30''-36° 30'; 120° 15'-120° 22' 30'').

Rio Bravo (35° 22' 30''-35° 30'; 119° 15'-119° 22' 30'').

California—Continued.

- Russell Valley (34° 6'–34° 12'; 118° 48'–118° 54').
 Seminole (34° 6'–34° 12'; 118° 42'–118° 48').
 Towne Oil Station (36° 22' 30'–36° 30'; 120° 7' 30'–120° 15').
 West Elk Hills (35° 15'–35° 22' 30''; 119° 30'–119° 37' 30'').
 West of Lethent (36° 15'–36° 22' 30''; 120°–120° 7' 30'').
 Wheatville (36° 22' 30'–36° 30'; 120°–120° 7' 30'').

Hawaii:

- Hilo (19° 30'–19° 45'; 155°–155° 15').
 Waikii (19° 45'–20°; 155° 30'–155° 45').

Idaho:

- Bayhorse (44°–44° 30'; 114°–114° 30').
 Salmon River, plan and profile, scale 1 inch=½ mile.

Idaho-Wyoming:

- Snake River, plan and profile, scale 1 inch=½ mile except on Sheet D.

Illinois (see also Kentucky-Illinois):

- Arenzville (39° 45'–40°; 90° 15'–90° 30').
 Barry (39° 30'–39° 45'; 91°–91° 15').
 Brussels (38° 45'–39°; 90° 30'–90° 45').
 Edwardsville (38° 45'–39°; 89° 45'–90°).
 Hannibal (39° 30'–39° 45'; 91° 15'–91° 30').
 Mackinaw (40° 30'–40° 45'; 89° 15'–89° 30').
 Manlio (40° 15'–40° 30'; 89° 45'–90°).
 Meredosia (39° 45'–40°; 90° 30'–90° 45').

Indiana (see Kentucky-Indiana).

Indiana-Kentucky-Ohio:

- Lawrenceburg (39°–39° 15'; 84° 45'–85°).

Iowa:

- Indianola (41° 15'–41° 30'; 93° 30'–93° 45').

Kentucky (see also Indiana-Kentucky-Ohio; Ohio-Kentucky; and Tennessee-Kentucky).

- Adolphus (36° 30'–36° 45'; 86° 15'–86° 30').
 Big Clifty (37° 30'–37° 45'; 86°–86° 15').
 Burnside (36° 45'–37°; 84° 30'–84° 45').
 Corydon (38°–38° 15'; 86°–86° 15').
 Eddyville (37°–37° 15'; 88°–88° 15').
 Fordsville (37° 30'–37° 45'; 86° 30'–86° 45').
 Hardinsburg (37° 45'–38°; 86° 15'–86° 30').
 Lafayette (36° 30'–36° 45'; 86°–86° 15').
 New Castle (38° 15'–38° 30'; 85°–85° 15').

Kentucky-Illinois:

- La Center (37°–37° 15'; 88° 45'–89°).

Kentucky-Indiana:

- La Grange (38° 15'–38° 30'; 85° 15'–85° 30').

Maine:

- Caribou (46° 45'–47°; 68°–68° 15').
 Eagle Lake (47°–47° 15'; 68° 30'–68° 45').
 Great Pond (44° 45'–45°; 68° 15'–68° 30').
 Portage (46° 45'–47°; 68° 15'–68° 30').
 Robbinston (45°–45° 15'; 67°–67° 15').
 Skinner (45° 30'–45° 45'; 70° 30'–70° 45').
 Spencer (45° 15'–45° 30'; 70° 15'–70° 30').

Maryland (see Virginia-Maryland).

Michigan:

- Bangor (42° 15'–42° 30'; 86°–86° 15').
 Holland (42° 45'–43°; 86°–86° 15').

Missouri:

- Fulton (38° 45'–39°; 91° 45'–92°).
 Mexico (39°–39° 15'; 91° 45'–92°).

Montana:

- National Bison Range (47° 17' 30'–47° 22' 30''; 114° 10'–114° 17' 30'')

New Hampshire:

- Franconia (44°–44° 15'; 71° 30'–71° 45').
 Littleton (44° 15'–44° 30'; 71° 45'–72°).
 Mount Chocorua (43° 45'–44°; 71° 15'–71° 30').
 Plymouth (43° 45'–44°; 71° 30'–71° 45').
 Rumney (43° 45'–44°; 71° 45'–72°).

New Hampshire-Vermont:

Mascoma ($43^{\circ} 30' - 43^{\circ} 45'$; $72^{\circ} - 72^{\circ} 15'$).

New Mexico:

Kirtland ($36^{\circ} 15' - 36^{\circ} 45'$; $108^{\circ} 15' - 108^{\circ} 45'$).Magdalena district ($34^{\circ} 3' 15'' - 34^{\circ} 9' 30''$; $107^{\circ} 10' 45'' - 107^{\circ} 13' 30''$).

New York (see also Pennsylvania-New York).

Amsterdam ($42^{\circ} 45' - 43^{\circ}$; $74^{\circ} - 74^{\circ} 15'$).

North Carolina (see Virginia-North Carolina).

North Dakota:

Flora ($47^{\circ} 45' - 48^{\circ}$; $99^{\circ} 15' - 99^{\circ} 30'$).Grahams Island ($48^{\circ} - 48^{\circ} 15'$; $99^{\circ} - 99^{\circ} 15'$).Oberon ($47^{\circ} 45' - 48^{\circ}$; $99^{\circ} - 99^{\circ} 15'$).Tokyo ($47^{\circ} 45' - 48^{\circ}$; $98^{\circ} 45' - 99^{\circ}$).

Ohio (see Indiana-Kentucky-Ohio).

Ohio-Kentucky:

Felicity ($38^{\circ} 45' - 39^{\circ}$; $84^{\circ} - 84^{\circ} 15'$).Higginsport ($38^{\circ} 45' - 39^{\circ}$; $83^{\circ} 45' - 84^{\circ}$).

Oklahoma:

Drumright ($35^{\circ} 45' - 36^{\circ}$; $96^{\circ} 30' - 96^{\circ} 45'$).Fairfax ($36^{\circ} 30' - 36^{\circ} 45'$; $96^{\circ} 30' - 96^{\circ} 45'$).Ripley ($36^{\circ} - 36^{\circ} 15'$; $96^{\circ} 45' - 97^{\circ}$).Skedee ($36^{\circ} 15' - 36^{\circ} 30'$; $96^{\circ} 30' - 96^{\circ} 45'$).Stroud ($35^{\circ} 30' - 35^{\circ} 45'$; $96^{\circ} 30' - 96^{\circ} 45'$).Yale ($36^{\circ} - 36^{\circ} 15'$; $96^{\circ} 30' - 96^{\circ} 45'$).

Oregon:

Madras ($44^{\circ} 30' - 45^{\circ}$; $121^{\circ} - 121^{\circ} 30'$).Three Sisters ($44^{\circ} - 44^{\circ} 30'$; $121^{\circ} 30' - 122^{\circ}$).

Pennsylvania:

Clearville ($39^{\circ} 45' - 40^{\circ}$; $78^{\circ} 15' - 78^{\circ} 30'$).Eagles Mere ($41^{\circ} 15' - 41^{\circ} 30'$; $76^{\circ} 30' - 76^{\circ} 45'$).Hyndman ($39^{\circ} 45' - 40^{\circ}$; $78^{\circ} 30' - 78^{\circ} 45'$).Karthaus ($41^{\circ} - 41^{\circ} 15'$; $78^{\circ} - 78^{\circ} 15'$).Snow Shoe ($41^{\circ} - 41^{\circ} 15'$; $77^{\circ} 45' - 78^{\circ}$).Townville ($41^{\circ} 30' - 41^{\circ} 45'$; $79^{\circ} 45' - 80^{\circ}$).

Pennsylvania-New York:

Corry ($41^{\circ} 45' - 42^{\circ}$; $79^{\circ} 30' - 79^{\circ} 45'$).Union City ($41^{\circ} 45' - 42^{\circ}$; $79^{\circ} 45' - 80^{\circ}$).

Standard symbols adopted by the Board of Surveys and Maps, United States of America. Chart, 22 by 33 inches.

Tennessee-Kentucky:

Red Bolling Springs ($36^{\circ} 30' - 36^{\circ} 45'$; $85^{\circ} 45' - 86^{\circ}$).

Texas:

Archer City ($33^{\circ} 30' - 33^{\circ} 45'$; $98^{\circ} 30' - 98^{\circ} 45'$).Aspermont ($33^{\circ} - 33^{\circ} 15'$; $100^{\circ} - 100^{\circ} 15'$).Beaumont ($30^{\circ} - 30^{\circ} 15'$; $94^{\circ} - 94^{\circ} 15'$).Bend ($31^{\circ} - 31^{\circ} 15'$; $98^{\circ} 30' - 98^{\circ} 45'$).Camp Springs ($32^{\circ} 45' - 33^{\circ}$; $100^{\circ} 30' - 100^{\circ} 45'$).Dennis ($32^{\circ} 30' - 32^{\circ} 45'$; $97^{\circ} 45' - 98^{\circ}$).Dundee ($33^{\circ} 30' - 33^{\circ} 45'$; $98^{\circ} 45' - 99^{\circ}$).Elm Mott ($31^{\circ} 30' - 31^{\circ} 45'$; $97^{\circ} - 97^{\circ} 15'$).Iola ($30^{\circ} 45' - 31^{\circ}$; $96^{\circ} - 96^{\circ} 15'$).Junction ($30^{\circ} 15' - 30^{\circ} 30'$; $99^{\circ} 45' - 100^{\circ}$).McGregor ($31^{\circ} 15' - 31^{\circ} 30'$; $97^{\circ} 15' - 97^{\circ} 30'$).Manning ($31^{\circ} - 31^{\circ} 15'$; $94^{\circ} 30' - 94^{\circ} 45'$).Morgan ($32^{\circ} - 32^{\circ} 15'$; $97^{\circ} 30' - 97^{\circ} 45'$).Mullin ($31^{\circ} 30' - 31^{\circ} 45'$; $98^{\circ} 30' - 98^{\circ} 45'$).Orange ($30^{\circ} - 30^{\circ} 15'$; $93^{\circ} 30' - 93^{\circ} 45'$).Orla ($31^{\circ} 45' - 32^{\circ}$; $103^{\circ} 45' - 104^{\circ}$).Paint Rock ($31^{\circ} 30' - 31^{\circ} 45'$; $99^{\circ} 45' - 100^{\circ}$).Rotan ($32^{\circ} 45' - 33^{\circ}$; $100^{\circ} 15' - 100^{\circ} 30'$).Rule ($33^{\circ} - 33^{\circ} 15'$; $99^{\circ} 45' - 100^{\circ}$).Springtown ($32^{\circ} 45' - 33^{\circ}$; $97^{\circ} 30' - 97^{\circ} 45'$).Stacy ($31^{\circ} 15' - 31^{\circ} 30'$; $99^{\circ} 30' - 99^{\circ} 45'$).Terry ($30^{\circ} - 30^{\circ} 15'$; $93^{\circ} 45' - 94^{\circ}$).Tow ($30^{\circ} 45' - 31^{\circ}$; $98^{\circ} 15' - 98^{\circ} 30'$).Valley Mills ($31^{\circ} 30' - 31^{\circ} 45'$; $97^{\circ} 15' - 97^{\circ} 30'$).Valley Wells ($28^{\circ} 15' - 28^{\circ} 30'$; $99^{\circ} 30' - 99^{\circ} 45'$).

Texas—Continued.

Vivian (34°-34° 15'; 99° 45'-100°).
 Voss (31° 30'-31° 45'; 99° 30'-99° 45').
 Whitney (31° 45'-32°; 97° 15'-97° 30').
 Zavalla (31°-31° 15'; 94° 15'-94° 30').

United States:

United States, scale 1 inch=40 miles.

Vermont (See New Hampshire-Vermont).

Virginia:

Colonial National Monument, Yorktown Battlefield (37° 11' 33''-37° 15' 14''; 76° 29'-76° 33').

Virginia-Maryland:

Wakefield (38°-38° 15'; 76° 45'-77°).

Virginia-North Carolina:

Stuart (36° 30'-36° 45'; 80° 15'-80° 30').

West Virginia:

Bald Knob (37° 45'-38°; 81° 30'-81° 45').
 Beckley (37° 45'-38°; 81°-81° 15').
 Eccles (37° 45'-38°; 81° 15'-81° 30').
 Fayetteville (38°-38° 15'; 81°-81° 15').
 Flattop (37° 30'-37° 45'; 81°-81° 15').
 Madison (38°-38° 15'; 81° 45'-82°).
 Montgomery (38°-38° 15'; 81° 15'-81° 30').
 Peytona (38°-38° 15'; 81° 30'-81° 45').

Wisconsin:

Alma (44° 15'-44° 30'; 91° 45'-92°).
 Cochrane (44°-44° 15'; 91° 45'-92°).
 Durand (44° 30'-44° 45'; 91° 45'-92°).
 Ferryville (43° 15'-43° 30'; 91°-91° 15').
 Gilmanton (44° 15'-44° 30'; 91° 30'-91° 45').
 Mondovi (44° 30'-44° 45'; 91° 30'-91° 45').
 Prairie du Chien (43°-43° 15'; 91°-91° 15').
 Wabasha (44° 15'-44° 30'; 92°-92° 15').

Wyoming (see Idaho-Wyoming).

THE YEAR'S OPERATIONS

Among the outstanding publications of the year are Professional Paper 163, on the significance of geologic conditions in Naval Petroleum Reserve No. 3 (Teapot Dome); Professional Paper 164, giving the results of a geographic and geologic reconnaissance of the Kaiparowits region, a large, little-known area in Utah and Arizona; Professional Paper 169, on the geology and ore deposits of the Bonanza mining district, Colorado; Professional Paper 172, on the gold quartz veins of the Alleghany district, California; Bulletin 833, on the mineralogy of drill cores from the potash field of New Mexico and Texas; and Water-Supply Paper 638-C, an outline of methods for estimating ground-water supplies.

A summary of the year's operations is given below.

GEOLOGIC WORK

The geologic work of the year was varied and widely distributed. It included economic and general studies of many mining districts in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, and Oregon; of lead and zinc deposits in Virginia; of iron ores in Alabama and the Lake Superior district; of coal fields in Montana, New Mexico, Oklahoma, and Utah; of oil fields and prospective oil and gas areas in California, Colorado, Mississippi, and Utah. Much of this work was carried on in cooperation with State surveys and other organizations.

The field work incident to the drilling of the last four wells of the 5-year potash exploration program was completed at the end of the year, but much laboratory and office work must still be done before all the stratigraphic and economic results of the investigation can be made available.

Areal mapping and stratigraphic, structural, and general geologic investigations were carried on in many areas in the Appalachian region, the Coastal Plain, and other parts of the country. Geologic work was done in 43 States in addition to the work of the volcanologic section in Hawaii, Alaska, and California.

EXPLORATIONS IN ALASKA

The work of the Geological Survey in Alaska, begun more than 30 years ago, is still in large part pioneer service under frontier conditions, though airplanes are being used for transportation to some of the remote camps. In the field season of 1931 eight field projects resulted in the geologic mapping of 5,976 square miles, of which 1,986 square miles represented revision on a larger scale of earlier surveys, and the topographic mapping of 5,680 square miles, of which 1,037 square miles represented revision. The Bureau of Mines cooperated in one of these projects. Of the total area of Alaska, 44.4 per cent has now been covered by geologic surveys and 47.3 per cent by topographic surveys. The broad survey of recent mining developments, the collection of mining statistics, and the supervision of operations under coal and oil leases on Government lands were continued. Progress in compiling drainage maps from the Navy Department aerial photographs added more than 1,000 square miles to the areas thus covered.

At the beginning of the fiscal year work had been started on 7 field projects chargeable to funds appropriated directly to the Geological Survey and 10 field projects undertaken under a special appropriation to the Alaska Railroad to discover resources that may contribute to railroad tonnage, funds being transferred to the Geological Survey for this purpose. The railroad projects included examinations in one coal area, five gold districts, and three areas where the lodes consist mainly of mixed sulphides and a general investigation of non-metalliferous deposits throughout the railroad belt. Cooperation in this work was furnished by the Bureau of Mines and the Alaska Road Commission.

Under the special appropriation to the Alaska Railroad contracts were let, in the spring of 1932, for core drilling in both the Moose Creek and Chickaloon coal areas to determine the areal extent and quality of coal in undeveloped portions of those fields. This work was carried out under direction of the Geological Survey.

TOPOGRAPHIC MAPPING

The topographic maps prepared as an essential base for detailed geologic mapping have proved to have hundreds of other uses, and the general realization of their value is shown in the increasing funds made available by States and other Federal units for cooperation in this work. The State cooperative funds during the year amounted to \$382,804.06 and were furnished by 15 States and 2 counties. Cooperation was furnished by the War Department in eight States, and by the Department of Justice in one State. The area mapped during the year amounted to 25,893 square miles, and the total area now mapped is 1,375,644 square miles. Ten States, the District of Columbia, and Hawaii are completely mapped, and the percentages in the other States range from 8 in Florida to 88.9 in Virginia. Of the continental United States, exclusive of Alaska, 45.2 per cent has been mapped. Office mapping from aerial photographs, by stereophotogrammetric methods, was completed for the Zion National Park and nearly completed for the Bryce Canyon National Park, both in Utah. An experimental project with a new 5-lens camera used at high altitudes, undertaken in cooperation with the Air Corps, United States Army, promises to reduce the amount of control needed. Maps were compiled and other illustrations assembled for publication in the George Washington Atlas.

INVESTIGATIONS OF WATER RESOURCES

The work on water resources consists primarily of the collection of facts in regard to the quantity, quality, availability, and utilization of water. The widespread interest in the availability of water for many uses has led to a persistent and increasing demand for reliable data that would serve as a basis for safe and sane developments. The work is done largely in cooperation with other Government organizations, with State, county, and municipal agencies, and with permittees and licensees of the Federal Power Commission. The amount expended by State, county, and municipal agencies for such work

during the year, in part directly and in part through the Geological Survey, was \$548,337.64. This sum covered work in 40 States and Hawaii. Including the cooperative work, the study of surface waters, which consists primarily of the measurement of the flow of streams, was carried on in 48 States, the District of Columbia, and Hawaii, in which at the end of the year 2,791 gaging stations were being maintained. In this work 39 of the States cooperated. Investigations relating to ground water or power and reservoir sites were made in 25 States, 15 of which cooperated, and in Hawaii. Research into the principles of hydrology and cooperation with well drillers' associations have been continued. In the hydrologic laboratory 283 samples of water-bearing material were analyzed. The work on quality of water involved the examination of 1,025 samples of water. Studies of the dissolved and suspended matter in the Colorado River and its tributaries were continued. The investigations of power resources included the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants, a report on the developed water power of the United States, and compilations of the stocks of coal held by electric public-utility power plants.

Studies of water utilization and flood control were continued and included investigations relating to the apportionment of water on international streams. Special field work was done in connection with 130 projects of the Federal Power Commission.

WORK IN CLASSIFYING AND LEASING PUBLIC LANDS

The classification of public lands with respect to their mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands were continued in 21 States and Alaska. The number of cases involving land classification acted on during the year was 12,913, and the results accomplished include net decreases of 816,873 acres in outstanding withdrawals for coal, of 54,100 acres in areas classified as oil-shale land, and of 115,293 acres in outstanding withdrawals for phosphate, and net increases of 508,480 acres in areas classified as coal and of 1,737 acres in areas classified as phosphate. At the end of the year the total area classified as mineral in character amounted to 36,889,563 acres in 14 States and Alaska, and the outstanding mineral withdrawals to 45,434,202 acres in 14 States. Definition of the "known geologic structure" of producing oil and gas fields was continued, and at the end of the year the net area so defined was 843,106 acres in seven States. Investigations to obtain information for classifying public land with respect to its value for the development of water power were made in four States. There was a net increase of 40,712 acres in the area included in power reserves, making a total of 6,577,185 acres in 21 States and Alaska, on which about 15,000,000 continuous horsepower can be developed. The net decrease in enlarged-homestead designations was 3,135,606 acres, making a total outstanding of 314,348,866 acres in 14 States, and the net increase in stock-raising homestead designations was 817,868 acres, making a total outstanding of 123,596,586 acres in 19 States. There was a net increase of 9,483 acres in public water reserves, and the total outstanding is now 447,836 acres in 12 States and Alaska. The supervisory work on public lands subject to the mineral leasing laws was increased by the issuance of 89 leases, 46 licenses, and 237 permits, covering 408,744.75 acres, and decreased by 1,304 cancellations and expirations of leases, permits, and licenses. The production of petroleum on such lands during the year was 26,454,217.11 barrels, of natural gas 50,876,816.000 cubic feet, and of gasoline 97,817,827.30 gallons, on which the royalty, rentals, and bonuses amounted to \$3,097,682.87. The production of coal on such lands was 2,880,448 tons, of phosphate rock 33,099 tons, of potash 45,967 tons, and of sodium salts 32,896 tons, on which the accrued royalty, rentals, and bonuses amounted to \$403,787.65. Supervision over oil and gas operations on naval petroleum reserves was continued, and the total production was 3,919,625.61 barrels of petroleum, 4,442,014,000 cubic feet of natural gas, and 18,539,144 gallons of gasoline, on which the royalty value was \$690,188.27. Inspectional, regulatory, and advisory service was rendered in connection with the leasing of mineral deposits on Indian lands in eight States. In general the demands for engineering advice and assistance are increasing as the supervisory duties under the leasing laws are more clearly defined and enlarged, and as the competence and impartiality of the supervisors become more widely known.

PUBLICATIONS

The publications of the year consisted of 82 books and pamphlets of the regular series, 141 new or revised maps, 378 reprinted maps, and numerous circulars, lists of publications, etc. The numbers of books and maps issued showed increases from 1931 ranging from 74 to 97 per cent. The total number of pages in the new book publications was 11,238, an increase of 30 per cent. In addition to the publications in the regular series, 71 brief reports, a few of them accompanied by maps, were issued in mimeographed form as memoranda for the press. The publications distributed numbered 893,438, of which 3,877 folios and 547,746 maps were sold for \$34,737.32.

GEOLOGIC BRANCH

T. W. STANTON, Chief Geologist

ORGANIZATION AND PERSONNEL

The administration of the geologic branch continued during the year to be conducted through 11 sections, as follows:

- Paleontology and stratigraphy, J. B. Reeside, jr., geologist, in charge.
- Geology of metalliferous deposits, G. F. Loughlin, geologist, in charge.
- Geology of areal and nonmetalliferous deposits, G. R. Mansfield, geologist, in charge.
- Geology of iron and steel metals, E. F. Burchard, geologist, in charge.
- Glacial geology, W. C. Alden, geologist, in charge.
- Coastal Plain investigations, L. W. Stephenson, geologist, in charge.
- Geology of fuels, H. D. Miser, geologist, in charge.
- Volcanology, T. A. Jaggar, jr., volcanologist, in charge.
- Petrology, C. S. Ross, geologist, in charge.
- Chemistry and physics, R. C. Wells, chemist, in charge.
- Geologic map editing, G. W. Stose, geologist, in charge.

Timothy W. Stanton was acting chief geologist until February 1, 1932, when he became chief geologist, and J. B. Reeside, jr., was made geologist in charge of the section of paleontology and stratigraphy.

At the end of the year the professional force included 132 geologists of various grades, many of whom are not employed continuously, 1 associate engineer, 9 chemists, and 3 physicists. The sub-professional force comprises 7 draftsmen (2 temporary), 1 chief scientific aid, 10 scientific aids (1 temporary), and 2 scientific helpers. The clerical force includes 28 clerks and 1 skilled laborer. The total number of employees in the branch is 194, and the changes during the year resulted in a net decrease of 5.

With the end of the fiscal year, under the provisions of the retirement section of the Federal economy act, the Geological Survey loses three well-known geologists who have to their credit many years of faithful and effective service.

Marius Robinson Campbell joined the Survey as a geologic aid in 1889 and has served continuously since then. The larger part of this time was given to the geology of coal fields, first in the Appalachian region, where he prepared several folios for the Geologic Atlas, and later in the Mississippi Valley and Rocky Mountain regions, and for some years with general supervision of all the work on the geology of fuels. He has also made valuable contributions to the classification of coal and to geomorphic studies in the Appalachian region as well as in the Rocky Mountain States.

Frank Charles Schrader began his work for the Geological Survey in 1896 and spent five years in exploratory geologic work in Alaska

in the pioneer days, soon after gold mining became active there. His further activities included areal mapping in Kansas, reconnaissance of coal fields in Colorado and Wyoming, and, during the last 25 years, the examination of metal-mining districts in Arizona, Idaho, Montana, Nevada, and Wyoming.

Edward Oscar Ulrich was recognized as an authority on the geology of the Mississippi Valley region when he joined the Survey in 1899. In his special fields of the Paleozoic stratigraphy, paleontology, and paleogeography he has won eminent distinction throughout the world. As chief adviser and arbiter on questions of Paleozoic stratigraphy and correlation, his services have been and are still frequently sought by the State geologists of many States, including Maryland, Virginia, Tennessee, Michigan, Wisconsin, Illinois, Missouri, and Oklahoma.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the geologic branch for the fiscal year were as follows:

Geologic surveys.....	\$400, 000
Research in geologic science.....	100, 000
Volcanologic surveys.....	35, 000
Classification of lands.....	20, 000
Repayments from other Federal departments.....	1, 046
Repayments from State and other cooperating organizations.....	26, 006
	<hr/>

582, 052

The expenditures from these funds may be classified approximately as follows:

Geologic investigations (economic and scientific, including volcanologic).....	\$472, 348
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc.....	107, 854
Unexpended balances.....	1, 850
	<hr/>

582, 052

WORK OF THE GEOLOGIC BRANCH

The work of the geologic branch is divided between fundamental geology and applied geology—between the development of the general principles and the discovery of the fundamental facts on which the science of geology is based and the application of those facts and principles in the discovery and investigation of the mineral resources of the country.

The purpose of its studies and surveys is to determine, as accurately as possible, the reserve supplies of coal, petroleum, and other minerals on the public domain; to aid the great metal-mining industry by making more comprehensive studies of mineralized districts and of the geologic history of the larger regions in which they lie than can ordinarily be made by individuals or mining companies, and thus to discover guiding principles of ore deposition that may lead to the finding of new sources of supply; to study the deposits of iron, manganese, chrome, and other raw materials necessary for the manufacture of steel; to continue the search for and investigation of possible further supplies of minerals of which the domestic supply

is still inadequate; to make fundamental contributions to the geology of mineral fuels by investigating the source rocks of petroleum and the structure and constitution of coals; to work out the geomorphic development and the glacial history of the country; to determine the details of stratigraphy, structure, and lithology of the sedimentary rocks and the chemical and mineral composition of igneous rocks; to describe and locate the successive fossil faunas and floras as essential elements in detailed studies of stratigraphy and correlation; to make available to the public trustworthy descriptions and explanations of the more remarkable natural features of the country; to keep accurate records of volcanic activity, earthquakes, and other earth movements; and in general to make the Geological Survey an efficient clearing house for full and accurate information on the geology and mineral resources of the country.

Cooperation in certain phases of geologic work with several of the States was continued throughout the year. Special mention should be made of the study of metal-mining districts in Colorado which has been actively prosecuted for several years. Similar cooperative work has been carried on in Idaho, Nevada, and New Mexico. The lead and zinc deposits of Virginia and the general geology of the valley of Virginia have been studied in cooperation with the State geological survey. The investigation of the mining districts and mineral resources of Oregon was continued with the aid of an unexpended balance of State funds previously appropriated. The geologic map of Texas, now in process of publication, was completed in cooperation with the State bureau of economic geology.

Research work was continued along varied lines of study in petrology, mineralogy, paleontology, stratigraphy, and mineralogy. The principal new projects undertaken deal with the source rocks of petroleum, the structure and constitution of coal, and the systematic study of diatoms.

The varied character of the work of the branch is exhibited in some detail under the heading "Work in geology by States."

INTERNATIONAL GEOLOGICAL CONGRESS

Guidebooks for the excursions of the International Geological Congress to be held in Washington in July, 1933, have been prepared by members of the Geological Survey and other geologists. Most of the guidebooks contain contributions by several authors and are detailed below under "Work in geology by States."

GEOLOGIC MAP OF THE UNITED STATES

The compilation of the geologic map of the United States was completed. (See p. 84.)

POTASH INVESTIGATIONS

FINAL DRILLING AND ANALYSES

Although the beginning of the fiscal year 1932 officially marked the end of the 5-year period of potash investigations carried on jointly by the Geological Survey and the Bureau of Mines under the act approved June 25, 1926 (44 Stat. 768), the final drilling contract remained in force until November, 1932, when the last test well

was completed. Under this contract three test wells were drilled in the fiscal year 1932. These were No. 21, in Lea County, N. Mex.; No. 22, in Eddy County, N. Mex.; and No. 24, in Grand County, Utah. No. 23, in Eddy County, N. Mex., the first well to be drilled under this contract, was completed shortly before the end of the fiscal year 1931, and the work of studying and analyzing the cores from it fell chiefly in the fiscal year 1932.

In addition to the material from Government test wells, core samples were also received from eight test wells drilled by the Potash Co. of America and one by the United States Potash Co. on Government land. Cores from seven of these wells were studied and analyzed within the fiscal year. Meanwhile the chemical and mineralogic study of cuttings from oil wells was continued, and 18 wells were recognized as furnishing in their cuttings definite evidence of the presence of sylvite, carnallite, or langbeinite, which are commercially more desirable potash-bearing minerals than polyhalite, which is the most abundant and widely distributed potash-bearing mineral thus far found in the Permian basin of Texas and New Mexico.

This study has shown that cuttings from an oil well, if carefully taken and if studied by a competent petrologist, may be expected to reveal the presence of any beds of sylvite or carnallite rich enough to have possible commercial value that the well may have penetrated. These minerals are so soluble that it has hitherto seemed improbable that they could be preserved in well cuttings in sufficient amounts to provide any reliable basis for prospecting. Now, it should be possible to reduce the costs of prospecting for potash by using the churn drill for preliminary exploration and reserving the core drill for checking the most favorable localities.

Three press statements were issued during the year giving the results of chemical and mineralogical tests of the cores from test wells 19 to 24 and summarizing the general results of the whole drilling program. Of these wells, Nos. 19, 20, and 21 were drilled in Lea County and Nos. 22 and 23 in Eddy County, N. Mex., and No. 24 in Grand County, Utah.

GENERAL RESULTS OF GOVERNMENT CORE TESTS

In all 24 core tests have been made—13 in New Mexico, 10 in Texas, and 1 in Utah. As an indirect result of this core-drilling program and of the 15 years of preliminary exploration, chiefly by the Geological Survey, whereby the oil companies and the public generally became "potash conscious," private companies have drilled 42 additional core test holes—2 in Midland County, Tex., and 40 in Eddy County, N. Mex. A shaft has been sunk by the United States Potash Co. in Eddy County about 18 miles northeast of Carlsbad, and shipments of untreated potash salts containing 25 to 30 per cent of K_2O have been made regularly by the company during the year. Thus a new potash industry has been created on American soil during the depression years 1929–1931.

Of the 24 Government tests 17 have revealed more than 50 intersections of polyhalite beds that are of possible economic interest. These beds range in thickness from 2 to about 10 feet and in potash content from 10 to nearly 15 per cent. Most of the private core tests have also cut comparable beds of polyhalite. Commercial in-

terest in many of these polyhalite beds is no doubt remote. Nevertheless, it should be borne in mind that the viewpoint of the Government toward mineral resources is somewhat different from that of industry. Industry seeks an immediate or early return upon invested capital; the Government must foresee and provide for the future requirements in mineral raw materials. Polyhalite contains magnesium and calcium as well as potash. If certain expected industrial uses for magnesium alloys should be developed the polyhalite beds in New Mexico and Texas should prove abundant sources for this metal, and by-product potash could probably be produced very cheaply.

Twelve of the tests have revealed the presence of sylvite, carnallite, or langbeinite. One of these has disclosed a 5-foot bed of sylvite and halite containing more than 30 per cent of K_2O and comparing favorably in content and thickness with the salts now being mined in Eddy County, together with an overlying 5-foot bed of halite with enough sylvite to yield 8.80 per cent K_2O . Two others have penetrated beds of similar salts but of lower grade that may also be considered of possible though more remote commercial interest.

In addition to core samples, thousands of samples of cuttings from many wells drilled for oil in the Texas-New Mexico field have been studied by the Geological Survey.

The Federal 5-year program of potash exploration, together with events that preceded it, has stimulated private exploration and exploitation of potash salts in the Permian basin of New Mexico and Texas. It has demonstrated the presence of great reserves of polyhalite and of at least one rich body of sylvite in the same general region. By improved methods of study applied to both oil-well cuttings and cores it has outlined a broad area in which the occurrence of sylvite is known and in which further exploration may locate additional commercial bodies of that mineral. It has also eliminated certain areas as being improbable sources of potash.

The potash possibilities in Utah have not been sufficiently tested, but from the known structural conditions and the results thus far obtained the prospects for commercial potash development in that State seem to be less favorable than in New Mexico or Texas.

WORK IN GEOLOGY, BY STATES

ALABAMA

In continuation of studies of the iron ores of Alabama in cooperation with the State geological survey, field work on the brown iron ores of the Russellville district was carried on by E. F. Burchard during the year. Field work on iron ore in the Red Mountain formation in northeastern Alabama has been completed, and it is expected that the report, now nearly complete, will be published by the State. A chapter on the red ores in Greasy Cove has been submitted for publication by the Federal Survey.

The southern Appalachian portion of northeastern Alabama has been mapped by A. I. Jonas and G. W. Stose for incorporation in the revised geologic map of the United States. This region has also been covered by Mr. Stose and Miss Jonas in the guidebook on the southern Appalachian region for the International Geological Congress. The Birmingham district has been described by E. F. Burchard in the guidebook on the mining districts of the Eastern States.

E. O. Ulrich and Josiah Bridge visited some early Paleozoic outcrops in northern Alabama to gather additional data as to the age and distribution of these formations in connection with their monographic study of the faunas of these formations in North America.

Marble quarries at Sylacauga and limestone quarries at Rockwood were examined by G. F. Loughlin, who made a report to the Architect of the Capitol on the availability of marble quarries in Alabama.

An article on revision of physical divisions of northern Alabama was submitted by W. D. Johnston, jr., for publication in *Science*.

ALASKA

As a part of the program of work of the section of volcanology, seismograph stations were maintained at Dutch Harbor and Kodiak. The seismograms from these stations were sent to T. A. Jaggar, jr., in Hawaii, and a record of earthquakes at these places from August, 1927, to December, 1931, with map and diagrams, was compiled by A. E. Jones and published in *Volcano Letter* No. 377. During 1929 and 1930 the Kodiak station recorded two and one-half times as many earthquakes as the Dutch Harbor station, but in 1931 Dutch Harbor reported 37 per cent more than Kodiak. On account of prospective lack of funds the observations at these stations were discontinued in the spring of 1932. The Akutan Crater was examined in the fall of 1931 by R. H. Finch, and in the spring of 1932 he made a trip to the northern slope of Shishaldin Volcano for sketch mapping, photography, and records of the eruption that had begun the preceding January. Mr. Finch prepared an illustrated account of the Akutan Crater accompanied by a contour sketch map of Akutan Island. Notes from the Aleutian Islands were published in the *Volcano Letter*.

ARIZONA

Geologic investigation of the Ajo mining district was begun by James Gilluly in the spring of 1932.

Further field investigations of the manganese deposits near Alamo were made by D. F. Hewett, for inclusion in a paper on the subject, of which B. N. Webber is joint author.

The manuscript of a report on correlation of Jurassic sandstones of southeastern Utah, northeastern Arizona, southwestern Colorado, and northwestern New Mexico, by J. B. Reeside, jr., A. A. Baker, and C. H. Dane, has been completed and submitted for publication as a professional paper.

A guidebook describing the geology, geography, and other interesting features along the route of the Southern Pacific Railroad is being prepared by N. H. Darton.

A paper on Algonkian strata in Arizona by Mr. Darton was submitted for publication in the *Journal of the Washington Academy of Sciences*.

David White continued studies relating to pre-Cambrian plant life in the Grand Canyon.

A guidebook by F. L. Ransome, J. B. Tenney, and Sidney Paige on ore deposits of the Southwest describes the geology and mining districts on the route of an excursion of the International Geological Congress through southern Arizona.

B. S. Butler examined and reported on the Charleston, Porphyry, Christmas, Riverside, and Buttes dam sites for the Indian Service.

A chart giving a tentative correlation of the named geologic units for Arizona, by M. Grace Wilmarth, was issued.

Publication: Professional Paper 164. (See p. 1.)

ARKANSAS

The cooperative report on the lead and zinc deposits of northern Arkansas by E. T. McKnight, which was revised to incorporate additional stratigraphic and mineralogic data, was completed.

Studies of the faunas of the Morrow formation of Arkansas and Oklahoma and the Batesville sandstone of Arkansas and Missouri were continued by G. H. Girty.

Structural and stratigraphic studies in the Ouachita Mountains of Oklahoma and Arkansas were continued by H. D. Miser.

Manganese deposits near Cushman were examined by D. F. Hewett, and the cinnabar deposits in Pike County were examined by Mr. Miser. He made a brief field study of manganese deposits in the Batesville district, and a report on recent developments in this district is in preparation by Messrs. Hewett and Miser.

David White is preparing a report describing the Wedington fossil flora of the Fayetteville shale, of Mississippian age, from northwestern Arkansas, and

a report on the fossil flora of the Jackfork sandstone and Stanley shale of Arkansas and Oklahoma. Collections of the Wedington flora were made near Fayetteville by C. B. Read. For comparative purposes, a study of plant material from the Tesnus, Haymond, and associated formations in western Texas and from the Atoka of eastern Oklahoma was made by Mr. White.

E. O. Ulrich and Josiah Bridge continued the study of fossils from certain formations of early Paleozoic age in connection with the preparation of a report on the early Paleozoic gastropods of North America.

R. D. Mesler collected Ordovician and Silurian fossils near Batesville, St. Joe, Gilbert, Pindall, Western Grove, and Jasper.

A paper on the Arkansas-Oklahoma coal field was presented by T. A. Hendricks at the February meeting of the American Institute of Metal and Mining Engineers and will be published in the proceedings of the institute.

An article on the Foraminifera of the Pecan Gap and Annona chalks, by J. A. Cushman, was submitted for outside publication.

Descriptions of Magnet Cove, Ark., by K. K. Landes, Bryan Parks, and V. E. Scheld, and of the Arkansas bauxite deposits, by G. C. Branner, form parts of the guidebook on the mining districts of the Eastern States.

CALIFORNIA

In continuance of the stratigraphic and petrologic investigations of the siliceous sediments and associated rocks of the Monterey group, geologic sections were measured and collections made in areas in the Coast Ranges between Los Angeles and San Francisco, by M. N. Bramlette and K. E. Lohman. Mr. Bramlette will make petrographic studies for the purpose of interpreting the origin of the siliceous formations, and Mr. Lohman will make a systematic study of the diatoms.

A study of the geology and geomorphology of the southern part of Death Valley and the surrounding country, including portions of the Panamint and Funeral Ranges, a region of unusual scientific and popular interest, is being undertaken by L. F. Noble, assisted temporarily by C. L. Gazin. This study will involve several seasons' field work. During the year field mapping was done in the southern part of the Furnace Creek quadrangle and the northern part of the Avawatz Mountains quadrangle.

Messrs. Noble and Gazin completed field work on the geology of the southern part of the San Andreas rift zone from Palmdale to the Mexican border. A comprehensive report covering the results of detailed studies over several years by Mr. Noble and assistants is in preparation.

In continuation of his scientific study of the southern California batholiths, E. S. Larsen, jr., continued geologic mapping in the San Luis Rey quadrangle. Additional field work will be required to complete this investigation.

The field study of the areal geology and underground structure of the Grass Valley mining district was completed by W. D. Johnston, jr., and the report on the investigation is in progress. A report on chromite deposits in northern California by Mr. Johnston is in preparation. He submitted papers on the geothermal gradient of the Mother Lode belt and the geothermal gradient at Grass Valley for publication in the Journal of the Washington Academy of Sciences and prepared a chapter on mesothermal gold-quartz veins of Grass Valley for the Lindgren volume of the American Institute of Mining and Metallurgical Engineers.

Work on a report on the geology and ore deposits of the Ivanpah quadrangle, by D. F. Hewett, has continued, and some progress has been made by H. G. Ferguson toward the completion of his report on the geology and ore deposits of the Hawthorne and Tonopah quadrangles.

The stratigraphic and structural studies of the Kettleman Hills oil and gas field were continued by W. P. Woodring and Ralph Stewart, and field work on the middle and south domes was completed. R. W. Richards continued his study of the subsurface and economic phases of the oil field, and R. M. Kleinpell examined Foraminifera from wells and outcrops in the hills.

Office work on a report on the geology of the San Pedro Hills was continued by W. P. Woodring, and a paper by him on a Miocene *Hallotis* from the Temblor Range was submitted for outside publication.

In connection with his studies on the source rocks of petroleum, P. D. Trask made examinations and collections in the Santa Fe Springs oil field.

G. B. Richardson completed a map of the oil and gas fields of the State for Survey publication.

Preparation of a report on the geomorphology of the upper San Joaquin Basin was continued by F. E. Matthes.

The north half of the geologic map of the State, which is being compiled in cooperation with the California Division of Mines, was completed and transmitted to the State mineralogist.

N. H. Darton continued work on a guidebook for the Southern Pacific Railroad.

J. B. Reeside, jr., studied Cretaceous ammonites.

A paper by C. H. Crickmay on Alpheus Hyatt's unfigured types from the Jurassic of California was submitted for publication in "Shorter contributions to general geology."

The work of the Lassen Volcano Observatory at Mineral, in charge of R. H. Finch, included the operation of the Lassen station and three seismograph stations, two new stations having been started at Loomis Museum and at Mount Harkness. The usual measurements of hot-spring temperatures and seismograph readings were continued. Mr. Finch made an ascent of Mount Lassen, a trip to a crater northwest of Glass Mountain, and an exploration of a slump scarp in Hat Creek, and ran a line of levels across an ancient lava flow. He submitted a descriptive article on slump scarps for publication in a scientific periodical and an article on burnt lava flows for the American Journal of Science. A new steam vent was discovered in the forest on the south slope of Diamond Peak, and an article describing this occurrence appeared in the Volcano Letter, December 3, 1931. During the summer of 1931 and the spring of 1932 Mr. Finch made trips to Alaska, and in his absence C. A. Huff was in charge and C. A. Anderson was employed for part of the time.

A guidebook on southern California, prepared under the direction of H. S. Gale, contains the following chapters:

Geology of southern California, by H. S. Gale.

Excursion to the San Andreas fault and Cajon Pass, by L. F. Noble.

Asphalt deposits and Quaternary life of Rancho La Brea, by Chester Stock.

General geology of the Los Angeles Basin, by H. W. Hoots.

Oil development in the Los Angeles Basin, by H. W. Hoots.

Section from the Repetto Hills to the Long Beach oil field, by R. D. Reed.

San Pedro Hills, by W. P. Woodring.

General geology of the eastern part of the Santa Monica Mountains, by H. W. Hoots.

Excursion in Los Angeles Basin and Santa Monica Mountains, by H. W. Hoots.

Los Angeles to Santa Barbara, by W. S. W. Kew.

A guidebook on middle California and western Nevada prepared under the direction of O. P. Jenkins contains the following chapters:

The geology of middle California, by A. C. Lawson.

The San Francisco Peninsula, by O. P. Jenkins.

San Francisco Bay, by W. M. Davis.

Berkeley Hills, by B. L. Clark.

Geography and geology of the Sierra Nevada, by F. E. Matthes.

Structure of the Sierra Nevada batholith, by Ernst Cloos.

The Mother Lode system, by Adolph Knopf.

The Tertiary auriferous gravel, by Adolph Knopf.

Itinerary, Yosemite to Mother Lode, by W. W. Bradley.

Up the western slope of the Sierra Nevada by way of the Yosemite Valley, by F. E. Matthes.

Eastern slope of the Sierra Nevada, by Eliot Blackwelder.

Reno and vicinity, by J. C. Jones and V. P. Gianella.

Itinerary, Reno to Pyramid Lake and return, by J. C. Jones.

Itinerary, Reno to Valley Hot Springs and return, by V. P. Gianella.

Publication: Professional Paper 172. (See p. 2.)

COLORADO

Cooperative work with the Geological Survey Board of Colorado and the Metal Mining Fund Board in the study of mining districts of Colorado was curtailed somewhat owing to decrease in available funds. B. S. Butler had general supervision of the cooperative work, and his annual progress report was read before the Colorado Mining Association. In carrying on the cooperative program priority was given to field work necessary for the preparation of a geologic map of the State. The manuscript copy of this map, prepared

ainly by W. S. Burbank and T. S. Lovering, assisted by other members of the olden office, was exhibited at the annual meeting of the Geological Society of America at Tulsa, Okla., and at the meeting of the Colorado Mining Association at Colorado Springs, after which it was brought to Washington by Mr. Burbank, who superintended its final preparation for the engraver.

A general report on the geology and ore deposits of the State is in preparation, and reconnaissance field trips to get data on the less known districts for its report were made by all members of the force in 1931 and 1932. E. B. Eckel is writing the chapter on mineralogy for the general report.

Mr. Lovering continued his study of the tungsten and gold deposits of the Colorado Front Range and prepared a paper and map showing their relation to faults in the region, which was promptly issued by the Colorado Scientific Society as an aid to prospecting and mine development. A report on the Nedern tungsten district by Mr. Lovering will be prepared for official publication.

N. Goddard made some progress in his study of the Jamestown district, but was diverted to assist Mr. Burbank, who continued his studies of districts in the San Juan area. Mr. Goddard also studied the complicated structure in Gunnison County and the Sangre de Cristo Mountains.

E. T. McKnight, assisted by E. B. Eckel, completed the field study of the Rico mining district, and Mr. Eckel wrote a scientific paper entitled "Pisanite from Rico."

C. H. Behre and Q. D. Singewald completed field studies in the Mosquito Range and made substantial progress on their report. J. H. Johnson studied the Permo-Carboniferous stratigraphy of this range. B. S. Butler and J. W. Vanderwilt studied the latest developments at Climax and transmitted their report on that district for publication. Mr. Vanderwilt nearly completed his field work in the Snowmass area and also made a study of vanadium deposits near Rifle.

G. F. Loughlin, after inspecting field parties in Colorado, spent a few days at Apple Creek studying the latest developments. He presented papers on the Apple Creek district before the Colorado Scientific Society and the Colorado Mining Association. The following papers resulting from the cooperative work are published or completed by their authors during the year. The papers not otherwise indicated are to be published by the Geological Survey.

Burbank, W. S., The Bonanza mining district. Professional Paper 169.

Johnson, J. H., Paleozoic formations of the Mosquito Range.

Lovering, T. S., Breckenridge mining district.

Butler, B. S., and Vanderwilt, J. W., The Climax molybdenum deposits of Colorado, with a section on history, production, metallurgy, and development by C. W. Henderson.

Behre, C. H., Weston Pass mining district. Colorado Scientific Society.

Behre, C. H., The peripheral facies of ore deposition at Leadville. Geological Society of America.

Behre, C. H., Physiographic history of the upper Arkansas and Eagle Rivers, Colo. Geological Society of America.

Burbank, W. S., and Goddard, E. N., Problems of structure and stratigraphy in the Sangre de Cristo Range, Colo. Geological Society of America.

Burbank, W. S., and Goddard, E. N., Thrust faulting in Huerfano Park. Colorado Scientific Society.

Butler, B. S., and Singewald, Q. D., Report on geology of Mount Lincoln and Russian mine, Park County, Colo. Colorado Scientific Society.

Johnson, J. H., Stratigraphic results of cooperative work in Colorado. Geological Society of America.

Lovering, T. S., and Johnson, J. H., The meaning of unconformities in the stratigraphy of central Colorado. American Association of Petroleum Geologists.

Lovering, T. S., Physiographic history of the Front Range. Colorado Scientific Society.

Lovering, T. S., and Van Tuyl, F. M., A contribution to the Cenozoic history of the Front Range. Geological Society of America.

Singewald, Q. D., Buckskin Gulch stock. Geological Society of America.

Vanderwilt, J. W., Treasury Mountain dome, Gunnison County, Colo. Geological Society of America.

Vanderwilt, J. W., Molybdenum deposits at Climax. American Institute of Mining and Metallurgical Engineers.

Eckel, E. B., Garnet as an amygdale mineral. American Mineralogist.

Semireconnaissance areal geologic mapping of the Tertiary and Upper Cretaceous formations of eastern Colorado, north of the Arkansas River and south of the Platte River, was continued by C. H. Dane and W. G. Pierce during the summer and early fall of 1931. This mapping was accompanied by stratigraphic studies, the collection of invertebrate fossils, and studies of the regional structure of the area, which forms part of the eastern flank of the Denver Basin. In June Messrs. Dane and Pierce made a supplemental review of portions of the area to obtain additional stratigraphic and structural information and fossil plants.

A preliminary paper on the San Juan region of southwestern Colorado by E. S. Larsen and Whitman Cross was transmitted for publication as a bulletin of the Survey. A paper by Mr. Larsen on the deuterite and later alterations of the uncompahgrite of Iron Hill was submitted for publication in the *American Mineralogist*.

R. W. Brown's paper on the recognizable species of the Green River flora, Utah, Colorado, and Wyoming, will be published in "Shorter contributions to general geology."

M. R. Campbell continued work on his report on the Yampa coal field and supplied additional data for land classification.

The report on the Book Cliffs coal field of western Colorado, by C. E. Erlmann, was submitted for Survey publication.

The Paradox formation of eastern Utah and western Colorado is being studied by C. H. Dane and A. A. Baker.

J. B. Reeside, jr., has in preparation a paper on the fauna of the Greenhorn limestone. Mr. Reeside attended a field conference with local geologists on the Fox Hills-Pierre boundary in northeastern Colorado for the State geologic map.

C. B. Read submitted for publication by the Washington Academy of Sciences a paper on a new *Trichopitys* from the Carboniferous of Colorado.

T. S. Lovering made geologic examinations in the Lost Park drainage basin for the Denver municipal waterworks and prepared a report thereon.

A guidebook on Colorado for the International Geological Congress excursions was prepared under the direction of C. W. Henderson, with the following chapters:

Geography, history, and mineral production of Colorado, by C. W. Henderson.

Life zones, faunas, and floras of Colorado, by Junius Henderson.

Grand Junction to Mesa Verde, by W. S. Burbank; Rico district, by E. T. McKnight.

Minturn to Florissant:

Introduction, by T. S. Lovering.

Battle Mountain mining district, by T. S. Lovering and C. H. Behre, jr.

Leadville mining district, by G. F. Loughlin and C. H. Behre, jr.

The molybdenum deposit at Climax, by J. W. Vanderwilt.

Alma district, by Q. D. Singewald.

Florissant to Colorado Springs; Cripple Creek mining district, by G. F. Loughlin.

Foothill region of north-central Colorado, by Junius Henderson and T. S. Lovering.

Denver to Nederland and Central City:

Introduction, by T. S. Lovering.

Geology of the Golden area, by F. M. Van Tuyl.

Road log, by C. E. Dobbin, T. S. Lovering, and F. M. Van Tuyl.

Ore deposits of Nederland, Central City, and Idaho Springs, by T. S. Lovering.

Fort Collins to Denver, by Junius Henderson and J. H. Johnson.

Publications: Professional Papers 168 and 169. (See p. 1.)

CONNECTICUT

E. B. Knopf extended her studies of the geology of ancient metamorphosed rocks to areas in western Connecticut, western Vermont, and western Massachusetts. She prepared a scientific paper on petrotectonics and petrotectonic methods. Additional contributions were made by Mrs. Knopf to the geology of western Connecticut for the revised geologic map of the United States, and

for the guidebook on eastern New York and western New England for the International Geological Congress.

Work on Pleistocene terraces is mentioned under Massachusetts.

DELAWARE

A study of the terraces of the Coastal Plain of Delaware was made by C. W. Cooke in connection with his general study of Coastal Plain terraces.

DISTRICT OF COLUMBIA

Pleistocene plants recently found in the District of Columbia were described by E. W. Berry in a paper prepared for the Washington Academy of Sciences.

FLORIDA

The cooperative report on the Miocene pelecypods of the Choctawhatchee marl of Florida, by W. C. Mansfield, was completed and transmitted to the Florida Geological Survey for publication, and a paper by Mr. Mansfield on faunal zones in that formation was submitted for publication in a scientific periodical. Mr. Mansfield is continuing his studies of the Tampa limestone of western Florida, a cooperative project with the State survey.

J. A. Cushman, assisted by L. G. Henbest, in cooperation with Gerald M. Ponton, of the Florida Geological Survey, prepared a report on the Foraminifera of the early Miocene for publication by the State.

Julia Gardner completed the revision and transmitted for publication the manuscript of part 1 of Professional Paper 142-F, on the gastropods of the Alum Bluff group of Florida. Part 2 of this report is in preparation.

GEORGIA

Stratigraphic studies of certain early Paleozoic formations in northern Georgia were made by E. O. Ulrich and Josiah Bridge to determine the age and distribution of the formations and to collect fossils in connection with their studies of these formations in North America.

A. I. Jonas and G. W. Stose did field work in the Appalachian Mountain section of northern Georgia in connection with the preparation of the geologic map of the United States and of a guidebook on the southern Appalachian region for the International Geological Congress.

The ore deposits of the Cartersville district have been described by G. W. Crickmay in a guidebook on mining districts of the Eastern States.

HAWAII

The scientific personnel of the section of volcanology at Volcano House, in the Hawaii National Park, comprises T. A. Jaggar, volcanologist in charge; E. G. Wingate, topographic engineer; A. E. Jones, seismologist; and H. A. Powers, geologist. Messrs. Wingate and Jones joined the staff early in the fiscal year.

The Halemaumau pit of Kilauea Volcano was active from December 23 to January 5.

The routine of the year has been as follows: Observation of the Hawaiian volcanoes, including constant observation and measurement of Kilauea and Mauna Loa; operation of seven seismographs and measurements of seismograms; issuance of the Volcano Letter (weekly to May 22, monthly thereafter); reporting Hilo tide data in cooperation with the Coast and Geodetic Survey; reporting Kilauea weather data in cooperation with the Weather Bureau; designing and building instruments for observing and registering volcanic and earthquake activities, including 10 shock recorders of new design and a clinoscope; building and operating three tilt cellars; field mapping and laboratory studies of volcanic geology in Hawaii; and local level and triangulation surveys.

Mr. Jaggar prepared a report on volcano events in 1931 for the American Geophysical Union and a paper on the eruption cycles in Hawaii for Thrumm's Annual (Honolulu), 1932, and published in the Volcano Letter articles on the progress of Hawaiian volcano research.

R. M. Wilson completed a manuscript on ground surface displacements at Kilauea, dealing with the results of his leveling and triangulation before and after the steam-blast eruption of Kilauea in 1924.

Four new permanent triangulation points as a base net for Halemau-man observations and three temporary points on the rim of the pit for map control were established by Mr. Wingate, and work was begun on a 1,000-foot contour map of the ocean floor around the entire Hawaiian ridge.

Mr. Powers spent some time completing detailed mapping of the lava flows of Hualalai Volcano and in petrographic laboratory studies and office work on a report covering these studies. He made reconnaissance trips to Moku-weoweo Crater on Mauna Loa and to Kohala and Mauna Kea volcanoes for collection of specimens, studied the Kilauea ash beds, and made observations during the activity of Halemau-mau. He prepared jointly with J. C. Ripperton and W. D. Goto a paper entitled "Survey of the physical features that affect the agriculture of the Kona District of Hawaii," which was published as Bulletin 66 of the Hawaii Agricultural Experiment Station.

A. E. Jones constructed a seismologic laboratory at the observatory and devised apparatus for regular determination of the physical constants of the seismographs. Records of local and distant earthquakes and other seismic movements were continuously kept up to date. Reports and graphs were prepared and published showing seismicity at Kilauea for the last two and one-half years. A special study was made of nine well-recorded local quakes on Hawaii. An expedition was made to the southern Kohala District to select locations for shock recorders and seismographs. The work of Mr. Jones in seismology has resulted in improved methods of operating all instruments and in securing more accurate results as well as bringing the records up to date and gradually measuring the seismograms of past years—work which has been at a standstill for some time.

The Hawaiian Volcano Research Association has continued cooperation in the work of the observatory. Articles on the work in Hawaii by members of the section have appeared during the year in the Volcano Letter, issued by this association.

IDAHO

Investigations of certain mining districts and mineralized areas in Idaho are being made by members of the Geological Survey in cooperation with the Idaho Bureau of Mines and Geology. Field work is now in progress in the Buffalo Hump and Elk City districts, by P. J. Shenon and J. C. Reed, with assistants from the State bureau. This work, which was begun in 1931 by Mr. Shenon, is expected to be completed this year. Work in the Yellow Pine and Thunder Mountain regions, begun in 1931 by A. L. Anderson and D. C. Livingston, is being continued by L. W. Currier and party, and a resurvey and detailed investigation of the geology and mineral resources of the Boise Basin region is being made by a party in charge of Mr. Anderson. A paper by Mr. Anderson on the genesis of mica pegmatites of Latah County was approved for publication in Economic Geology.

C. P. Ross has in hand for Survey publication reports on the geology and ore deposits of the Bayhorse quadrangle and some ore deposits in the Boise Basin and a professional paper on south-central Idaho. His report on the geology and ore deposits of the Casto quadrangle was completed for Survey publication. He prepared a chapter on the igneous geology of Idaho for the Lindgren volume of the American Institute of Mining and Metallurgical Engineers, a paper on the geology and ore deposits of the Thunder Mountain district for outside publication, and a contribution on geology of the Snake River Basin, with reference to hydrology, for inclusion in Water-Supply Paper 657.

Edward Sampson made some progress on his report on the Pend Oreille district.

G. R. Mansfield continued work on his report on the geology of the Paradise Valley and Ammon quadrangles. He prepared a paper on further developments in the geology of southeastern Idaho for presentation before the Geological Society of Washington and a paper on the Rocky Mountain phosphate field for the Lindgren volume.

Some progress was made by W. C. Alden on his report on glacial geology and physiography of northern Idaho.

A paper on Miocene plants from Idaho, by E. W. Berry, will be published in "Shorter contributions to general geology."

R. W. Brown and C. B. Read began the preparation of a paper on species of *Tempskya* from the Cretaceous and Upper Jurassic of Idaho. Mr. Brown has in preparation a paper on a Miocene florule from Salmon.

The Cabinet Gorge dam site was examined and reported on by J. T. Pardee for the Bureau of Reclamation.

Work in the Afton quadrangle is noted under Wyoming.

ILLINOIS

The report on the geology of the Hardin and Brussels quadrangles, by W. W. Rubey, prepared in cooperation with the Illinois Geological Survey, was completed and transmitted for State publication.

A paper on the fluorspar deposits of southern Illinois, by E. S. Bastin, is included in the guidebook on mining districts of the Eastern States. A paper on the Quaternary period in the Mississippi River Basin, by W. C. Alden, and an annotated guide across Illinois, by M. M. Leighton and G. E. Ekblaw, are included in the guidebook on glacial geology of the Central States prepared under the direction of Mr. Alden.

INDIANA

A report on two new crinoid genera from the Devonian and Silurian of Indiana is in preparation by Edwin Kirk.

G. H. Girty is preparing a report on the gastropods of the Spergen limestone, and P. V. Roundy a paper on *Persparchites* from the Spergen limestone.

The Indiana oolitic limestone district is described by G. F. Loughlin in the guidebook on mining districts of the Eastern States.

IOWA

A study of the Kinderhook fauna is in progress by G. H. Girty and J. S. Williams.

An annotated guide of eastern Iowa, by G. F. Kay, is included in the guidebook on glacial geology of the Central States.

KANSAS

Field investigation, including structural mapping of the Shoestring sand bodies and subsurface study of oil pools in Greenwood and adjacent portions of Butler and Lyon Counties, was carried on by N. W. Bass, in cooperation with the Kansas Geological Survey.

C. B. Read made a study of the Wellington shale of Permian age in the vicinity of Elmo and collected fossil plants from the Elmo limestone.

R. C. Moore continued assembling data for the revised geologic map of Kansas.

J. B. Reeside, jr., studied Hydrozoa from the Niobrara chalk, and P. V. Roundy continued his study of microfossils from the Carboniferous of Kansas.

A guidebook on the Pennsylvanian of the northern mid-continent region (Kansas, Oklahoma, and Texas) was prepared by Raymond C. Moore.

LOUISIANA

Studies of salt-dome cap rock and preparation of the report were continued by M. I. Goldman. Mr. Goldman submitted for publication in "Shorter contributions to general geology" a paper on the origin of the anhydrite cap rock of American salt domes.

The route of the Southern Pacific Railroad in Louisiana is being described by N. H. Darton for a geologic guidebook.

MAINE

Arthur Keith did additional field work and compiled data for the revision of the geology of Maine for the geologic map of the United States and presented a paper on the geology of Maine at the Tulsa meeting of the Geological Society of America.

MARYLAND

Field work on the geology of Washington County, a cooperative project with the Geological Survey of Maryland, was continued by G. W. Stose.

R. W. Brown and C. B. Read are preparing a paper on the *Tempaskya* from the Cretaceous and Upper Jurassic of Maryland to be embodied in a general report on this subject.

The coastal terraces of Maryland are being studied by C. W. Cooke.

A guidebook on the Chesapeake Bay region, Maryland and Virginia, was prepared by L. W. Stephenson, C. W. Cooke, and W. C. Mansfield, and a guidebook on southern Maryland by Mr. Cooke. The guidebook on southern Pennsylvania and Maryland, by G. W. Stose, A. I. Jonas, and G. H. Ashley, includes a description of the geology on the route from Washington to Harrisburg and the route from Washington to Baltimore and York.

MASSACHUSETTS

L. M. Prindle reviewed in the field portions of the geology of the Taconic quadrangle in connection with his detailed report on this area. He was accompanied by E. B. Knopf on some of these field trips for the purpose of gathering data for the revision of the geology of western Massachusetts for the geologic map of the United States. A joint paper on the geology of the Taconic quadrangle, covering the area between the Hudson River and the Green Mountains, by Mr. Prindle and Mrs. Knopf, was approved for publication in the *American Journal of Science*. A guidebook on eastern New York and western New England, by C. R. Longwell and others, includes sections on the structure, stratigraphy, and metamorphism in the disturbed belt of western Massachusetts.

Pleistocene terraces of the Connecticut River were examined by C. W. Cooke in connection with his studies of shore lines and terraces of the Atlantic coast.

MICHIGAN

Chapters on the Marquette range, by C. O. Swanson; mining on the Marquette range, by F. G. Pardee; geology, exploration, and mining in the Michigan copper district, by T. M. Broderick; the Gogebic range, by W. O. Hotchkiss; and mining in the Gogebic range, by F. G. Pardee, form part of the guidebook on the Lake Superior region prepared under the direction of W. O. Hotchkiss.

Work in the Lake Superior iron-ore district is noted under Minnesota.

MINNESOTA

Andrew Leith, R. J. Lund, and Gordon Atwater spent some time in field work in the Lake Superior iron-ore district for a revision of the correlation of the geologic formations of the Lake Superior region. A revised map and report are in preparation.

D. F. Hewett examined manganese deposits near Ely.

The Lake Superior guidebook prepared for the International Geological Congress includes chapters on Duluth rocks and structure, by F. F. Grout; the Mesabi range, by J. W. Gruner; and the Cuyuna iron-ore district, by Carl Zapffe.

MISSISSIPPI

Field mapping of the areal, structural, and stratigraphic geology of the Jackson, Florence, and Pelahatchee quadrangles was completed by W. H. Monroe, who also did detailed mapping in the Morton quadrangle and in the western edge of the Forest quadrangle and made subsurface structural and stratigraphic studies of the Jackson gas field. Mr. Monroe prepared a paper entitled "Notes on pre-Tertiary rocks in deep borings at Jackson, Miss.," and a brief article on earth cracks in Mississippi, a phenomenon noted by him incident to his field work in the Florence and Jackson quadrangles, for publication by the American Association of Petroleum Geologists.

Brief examinations of deposits of siderite, bauxite, and fuller's earth in Benton and Tippah Counties were made and specimens obtained by Mr. Monroe for D. F. Hewett and E. F. Burchard.

Publication: Bulletin 831-A. (See p. 2.)

MISSOURI

Edwin Kirk is preparing a paper on minute crinoids from the Mississippian formations of Missouri and Oklahoma.

A report on the Kinderhook fauna of Missouri and Iowa is in preparation by J. S. Williams and G. H. Girty. In connection with his studies of the Kinderhook formation, Mr. Williams did field work near Louisiana, Mo. He also, with members of the Missouri Bureau of Geology and Mines, studied the Mississippian formations near Springfield and other localities in the State.

Mr. Williams revised a manuscript on buried and resurrected hills of the central Ozarks, prepared jointly with C. L. Dake, for publication by the American Association of Petroleum Geologists.

E. O. Ulrich and Josiah Bridge made a field study of some early Paleozoic sections with members of the Missouri Bureau of Geology and Mines and studied fossils of the Cotter and Powell formations in connection with their general study of the early Paleozoic gastropods of North America.

Chapters for the guidebook on mining districts of the Eastern States were prepared on the disseminated lead districts of southeastern Missouri, by H. A. Buehler; the iron-ore deposits of Iron Mountain, by M. C. Lake; the iron deposits of Pilot Knob, by Edward Steidtmann; and the tri-State zinc-lead region, by Samuel Weldman.

Study of the Batesville sandstone of Missouri is noted under Arkansas.

MONTANA

Reconnaissance glacial and geomorphic studies of western Montana were continued by W. C. Alden. The results will be included in his report on the glacial geology and geomorphology of western Montana, northern Idaho, and eastern Washington, the preparation of which progressed during the year.

The report on the mining districts of the Greater Helena region, by J. T. Pardee and F. C. Schrader, was completed early in the year and will be published as a bulletin of the Survey.

Mapping of the areal geology and examination of mines and prospects in the Libby quadrangle were continued by Russell Gibson, who also continued office work on his report.

A study of the Pioneer mining district, Powell County, is in progress by J. T. Pardee. He also made brief examinations of the manganese deposits at Phillipsburg, the vermiculite deposits near Hamilton, Ravalli County, and phosphate areas in Granite and Powell Counties.

D. F. Hewett reexamined manganese deposits at Butte.

Geologic investigations of the Flathead mine and vicinity, including mine mapping, were made by P. J. Shenon.

A. J. Collier, assisted by M. M. Knechtel and F. S. Parker, continued geologic field studies in the Little Rocky Mountains and made reconnaissance examinations in eastern Montana to gather data for the State geologic map, which is being compiled in cooperation with the Montana Bureau of Mines and Geology. The report on the geology of the Little Rocky Mountains and surrounding plans, by Messrs. Collier and Knechtel, has been practically completed, and office work on their report on the McCone County lignite field was continued.

Detailed mapping of the coal beds, structure, and stratigraphy of a portion of Custer County, primarily for the classification of the lands as to coal, was made by a party in charge of F. S. Parker. This is an extension eastward and northward of similar investigations made in previous years in Custer and Powder River Counties.

The reports on the geology of the Rosebud Creek coal field, Rosebud and Custer Counties, by W. G. Pierce, and on the Richey-Lambert coal field, Richland and Dawson Counties, by F. S. Parker, were nearing completion at the end of the year. Mr. Parker also gave some time in the office to compilation of results of his studies last season in Custer County coal fields, and Mr. Pierce worked on his report on Pleistocene terraces in eastern Montana.

The report on the geology and ground-water resources of Big Horn County and the Crow Indian Reservation, by W. T. Thom, Jr., G. M. Hall, and others, was completed for publication as a bulletin of the Survey.

A guidebook on the Butte mining district was prepared by Eugene S. Perry.

Work on the Fort Union and associated formations is noted under North Dakota and on the Rocky Mountain phosphate field under Idaho.

NEVADA

Work in cooperation with the Nevada Bureau of Mines in a study of some of the mining districts of the State was continued. Field work in the Searchlight mining district was carried on by Eugene Callaghan and Harold Thomas; the brucite deposits northeast of Luning were examined by Mr. Callaghan, and a beginning was made in a reconnaissance survey of the Eldorado Canyon district. The report on the geology and ore deposits of the Tonopah mining district, by T. B. Nolan, is well advanced. A report on the Gold Range district is being prepared by H. G. Ferguson, and short papers on several mining districts of eastern Nevada, the field work for which was completed last year,

are being prepared by F. C. Schrader, who also has in preparation a report on mining districts in the Carson Sink region. Mr. Ferguson's report on the geology and ore deposits of the Tybo mining district has been completed and will be submitted to the State for publication. Field work for a resurvey of the Eureka mining district was begun by Mr. Nolan in the early summer of 1932.

Progress has been made on the detailed reports on the geology and ore deposits of the Hawthorne and Tonopah quadrangles, by H. G. Ferguson, and on the geology and ore deposits of the Ivanpah quadrangle and the geology of the Great Basin, by D. F. Hewett.

Edwin Kirk continued office work on his studies of the Eureka quartzite of the Great Basin.

S. W. Muller collected fossil invertebrates and made stratigraphic studies of sections in the Pilot Mountains, Garfield Hills, Gabbs Valley Range, and Eldorado Canyon south of Dayton.

T. B. Nolan examined two dam sites on the Walker River for the Indian Service.

A guidebook covering part of Nevada is noted under California.

Publication: Professional Paper 162. (See p. 1.)

NEW HAMPSHIRE

Field examinations in southern New Hampshire were made by Arthur Keith to aid in drawing geologic boundaries for the geologic map of the United States.

NEW JERSEY

The guidebook on mineral deposits of New Jersey and eastern Pennsylvania, prepared under the direction of C. P. Berkey, contains chapters on zinc deposits near Franklin, N. J., and on the area from Franklin Furnace, N. J., to eastern Pennsylvania, by P. F. Kerr.

M. R. Campbell, in cooperation with Florence Bascom, made several short field trips to New Jersey in connection with studies of gravel deposits under a grant from the National Research Council.

A report on the minerals of Franklin and Sterling Hill, by Charles Palache, was submitted for publication as a professional paper of the Survey.

Publications: Bulletins 828 and 832. (See p. 2.)

NEW MEXICO

Field mapping of the coal beds, stratigraphy, and structure of the portion of the San Juan Basin adjacent to the south and east sides of Mount Taylor, begun in the spring of 1931, was continued by C. B. Hunt and party. In the early summer of 1932 Mr. Hunt made a field study of the structural relations and the igneous rocks of Mount Taylor and the volcanic rocks in the Rio Puerco Valley. He is preparing a report on the geology and fuel resources of the Mount Taylor region and has submitted a short paper entitled "The junction of three orogenic types in northwest New Mexico" for publication in the *Journal of the Washington Academy of Sciences*.

A report on the geology and fuel resources of a portion of the San Juan Basin extending from Gallup eastward to Mount Taylor was completed by J. D. Sears.

A report on the geology and coal resources of an area in San Juan, McKinley, and Sandoval Counties was completed by C. H. Dane, for Survey publication, and a paper entitled "Notes on Puerco and Torrejon formations, San Juan Basin," was submitted by Mr. Dane for publication in the *Journal of the Washington Academy of Sciences*.

The report on the geology and mineral resources of the Santa Rita district has been practically completed by A. C. Spencer, with the assistance of Sidney Paige, and progress was made on the report on the geology and ore deposits of the Magdalena district by G. F. Loughlin and A. H. Koschmann. A paper entitled "Dissected sediments in the Magdalena district" was prepared by Mr. Koschmann for publication in the *Journal of the Washington Academy of Sciences*. S. G. Lasky is preparing a paper on mineralogy, contact metamorphism, and ore deposits of the Magdalena district.

The Central mining district, Grant County, and the Virginia mining district are being studied by Mr. Lasky in cooperation with the New Mexico Bureau of Mines.

W. B. Lang presented a review of petroleum developments in New Mexico in 1931 at the meeting of the American Institute of Mining and Metallurgical Engineers in February, 1932.

G. H. Girty continued his study of the Abo fauna of La Luz Canyon.

D. F. Hewett examined manganese deposits near Deming.

A chart giving a correlation of the named geologic units in New Mexico, by M. Grace Wilmarth, was issued.

G. R. Mansfield discussed the potash field of New Mexico and Texas in a chapter for the Lindgren volume of the American Institute of Mining and Metallurgical Engineers.

Potash investigations in New Mexico are described on pages 11-13.

Several projects covering areas lying partly in New Mexico are noted under Arizona and Texas.

Publication: Bulletin 823. (See p. 2.)

NEW YORK

Edwin Kirk transmitted for unofficial publication a paper entitled "An early estimate of the age of the Niagara Gorge."

Mr. Kirk made field studies of the Middle Devonian of New York and visited several museums in the State in a study of Paleozoic invertebrates. E. O. Ulrich and Josiah Bridge visited Ordovician fossil localities.

E. B. Knopf continued her studies of the geology of the ancient metamorphosed rocks in the Clove and Millbrook quadrangles.

A guidebook on the Paleozoic stratigraphy of New York, prepared under the direction of D. H. Newland, includes the following chapters:

Introduction and outline, by D. H. Newland.

Albany to Binghamton, by Winifred Goldring.

The Finger Lake region, by O. D. von Engeln.

Hornell to East Aurora, by C. A. Hartnagel.

East Aurora to Niagara Falls, by J. T. Sanford.

Niagara Falls and Gorge, by F. B. Taylor.

Niagara Falls to Rochester, by C. A. Hartnagel.

The Rochester region, by H. L. Alling and J. E. Hoffmeister.

Rochester to Utica, by C. A. Hartnagel.

Utica to Albany, by Rudolf Ruedemann.

A guidebook on eastern New York and western New England includes chapters on the stratigraphy and structure of the Hudson Valley and the structure and petrology of the anorthosite and related pre-Cambrian rocks in the Adirondack Mountains.

Work in the Taconic quadrangle is noted under Massachusetts.

NORTH CAROLINA

A. I. Jonas and G. W. Stose did field work in the southern Appalachian region of North Carolina and compiled data on the geology for incorporation in the geologic map of the United States and the guidebook on the southern Appalachian region.

C. S. Ross and Paul F. Kerr submitted an article on the manganese minerals of a vein near Bald Knob, for publication in the American Mineralogist.

Publication: Geologic Folio 222. (See p. 3.)

NORTH DAKOTA

R. W. Brown completed the field study of the Fort Union and associated formations in western North Dakota and adjacent portions of Montana and Wyoming with special reference to the occurrence of the fossil flora. T. W. Stanton was associated with him in the field during the early part of the fiscal year.

A chart giving the correlation of the named geologic units in North and South Dakota was compiled by M. Grace Wilmarth.

OHIO

Taisia Stadnichenko collected coal samples from the Lower Kittanning beds in coal mines in eastern Ohio for study of processes of coal metamorphism.

OKLAHOMA

Geologic mapping of the coal deposits of a part of the southeastern Oklahoma coal field, extending from the McAlester quadrangle to the Arkansas line in Latimer and Le Flore Counties, was carried on by T. A. Hendricks, assisted by C. B. Read. Mr. Hendricks completed his report on the geology and economic resources of the McAlester quadrangle and made progress in the preparation of a report on the Wilburton-Poteau district.

In connection with P. D. Trask's study of organic constituents of sediments from four American oil fields, material from the Burbank field was collected and studied.

G. H. Girty continued office work on his papers on the Morrow fauna and the Moorefield fauna. P. V. Roundy continued his studies of the microfaunas of the Sycamore formation, Caney shale, and Moorefield shale and worked on a paper on Carboniferous microfossils associated with *Chara* from well cores.

H. D. Miser, N. W. Bass, T. A. Hendricks, C. B. Read, and P. B. King attended the Kansas Geological Society field conferences in the Arbuckle and Wichita Mountains, and Messrs. Miser and Trask attended a field excursion of geologists in the Arbuckle and Ouachita Mountains. Mr. Miser prepared a paper on the Oklahoma structural salient of the Ouachita Mountains for the meeting of the Geological Society of America at Tulsa.

Ordovician and early Silurian geologic sections in the Arbuckle and Wichita Mountains were studied by E. O. Ulrich and Josiah Bridge, and fossil material was collected by them in connection with their studies of early Paleozoic gastropods of North America. C. B. Read collected fossil plants from the Woodford chert in the Arbuckle Mountains. Mr. Read is preparing a paper on the fossil flora of the Hartshorne sandstone, of Pennsylvanian age.

P. V. Roundy compiled data for the Indian Service regarding desirable sites for gas wells in the Osage Indian Reservation.

A guidebook on the Pennsylvanian of the northern mid-continent region (Kansas, Oklahoma, and Texas) was prepared by R. C. Moore. A guidebook on the petroleum geology and stratigraphy of Oklahoma and Texas was prepared under the direction of W. E. Wrather.

Work by Edwin Kirk on crinoids is noted under Missouri, and several projects lying partly in Oklahoma are noted under Arkansas.

OREGON

In continuation of the cooperation with the Oregon State Mining Board, field work was done in the mineralized areas of the Cascade Mountains by Eugene Callaghan, and the placer deposits of the western coast of southern Oregon were examined by J. T. Pardee. In eastern Oregon B. N. Moore continued field work on the nonmetallic resources, making examinations of limestone deposits, coal mines, diatomaceous deposits, asbestos, and pumice deposits. His report on these resources is practically completed. Substantial progress has been made on reports covering field work of previous seasons on these cooperative projects, and some of the manuscripts were completed for publication. P. J. Shenon's reports on the Robertson, Humdinger, and Robert E. gold mines and vicinity, southwestern Oregon, which will contain notes on the Chieftain and Continental mines, South Myrtle Creek, by F. G. Wells, and on the geology and ore deposits of the Takilma-Waldo district have been completed and will appear in "Contributions to economic geology." A report on the metalliferous deposits of the Cascade Range in preparation by Eugene Callaghan will include the results of work in the Bohemia and Blue River districts.

Reports on the Oregon gold placers by J. T. Pardee, the quicksilver deposits of southwestern Oregon by F. G. Wells, and the copper deposits in the Squaw Creek and Silver Peak districts and in the Alameda mine by P. J. Shenon are in progress. Mr. Pardee also prepared a report on the geology of dam sites near Troy and Cloverdale for the conservation branch.

The diatoms of eastern Oregon are being studied by K. E. Lohman.

James Gilluly completed his report on the ore deposits of eastern Oregon and a paper on the origin of the albite granite near Sparta, for Survey publication, and a paper with J. C. Reed on the heavy mineral assemblage of some of the plutonic rocks of eastern Oregon, for the American Journal of Science. He continued preparation of a report on the geology of the Baker quadrangle.

F. E. Matthes prepared a revised descriptive text for the reprint of the Crater Lake topographic map.

A guidebook on central Oregon was prepared by R. W. Chaney.

Publication: Bulletin 830-A. (See p. 2.)

PENNSYLVANIA

Work on cooperative projects with the Pennsylvania Topographic and Geologic Survey included completion of the field investigations of the geology of the Hanover and York quadrangles, by G. W. Stose and A. I. Jonas, and

office work on a report to be published as a bulletin of the United States Geological Survey. Additional field work in the New Cumberland quadrangle was done by Mr. Stose, and his portion of the text and the geologic map have been completed and submitted to the State for publication. The results of studies on the general structure of the region of the Hellam Hills, in the Middletown and York quadrangles, by Mr. Stose and Miss Jonas, will be submitted to some scientific periodical.

Revision of the manuscript for the report on the geology of the Bellefonte quadrangle, by E. S. Moore, was completed by Charles Butts for Survey publication, and progress was made by Mr. Butts on his report on the geology and mineral resources of the Tyrone quadrangle.

G. B. Richardson made further field examinations and collected data on oil and gas development in the Butler and Zellenople quadrangles for his detailed report covering these quadrangles, which is nearing completion.

In connection with studies on the effect of progressive metamorphism in the Lower Kittanning coal beds of Pennsylvania, Ohio, and West Virginia, Taisia Stadnichenko collected samples from these beds in coal mines at Clymer, Force, Cadogan, Johnston, and St. Michael.

M. R. Campbell and T. A. Hendricks made a field trip to the anthracite fields of Pennsylvania in connection with their coal-classification studies.

A guidebook on the mineral deposits of New Jersey and eastern Pennsylvania, prepared under the direction of C. P. Berkey, contains the following brief chapters on Pennsylvania:

The Bangor-Pen Argyl slate region, by C. H. Behre, jr.

The Lehigh Portland-cement district, by B. L. Miller.

Bethlehem to Nesquehoning, by B. L. Miller.

The anthracite field of Pennsylvania, by M. R. Campbell.

Anthracite field—Mauch Chunk to Lebanon, by G. H. Ashley.

The Cornwall iron mines, near Lebanon, by W. L. Cumings.

Lebanon to Harrisburg, by W. L. Cumings.

Geology of the Cornwall iron mines, near Lebanon, by G. W. Stose.

A guidebook on southern Pennsylvania and Maryland, by G. W. Stose, A. I. Jonas, and G. H. Ashley, contains a section on Washington to Harrisburg, Juniata River and Cornwall mines.

Publications: Bulletins 828 and 829. (See p. 2.)

SOUTH CAROLINA

C. W. Cooke did field work on the Cretaceous, Eocene, and Pleistocene formations in connection with the preparation of a geologic map to accompany his report on the geology of the Coastal Plain region of South Carolina and continued preparation of the general report on the area.

The guidebook on the southern Appalachian region is noted under Alabama.

SOUTH DAKOTA

A chart giving a correlation of the named geologic units in North and South Dakota, by M. Grace Wilmarth, was issued.

A guidebook on the Black Hills, prepared under the direction of C. C. O'Harra, contains the following papers:

General geology, by C. C. O'Harra.

Western and northern Black Hills, by C. C. O'Harra and J. P. Connolly.

Central Black Hills, by J. P. Connolly.

White River badlands, by G. L. Jepsen.

TENNESSEE

E. O. Ulrich and Josiah Bridge visited certain outcrops of early Paleozoic formations in eastern Tennessee to gather data and fossils for their general study of gastropods of the early Paleozoic formations of North America.

Messrs. Ulrich, Bridge, and Currier visited the zinc-mining areas in northern Tennessee to determine the origin of breccias in zinc areas.

Papers on the Ducktown mining district, by W. H. Emmons, and the Mascot-Jefferson City zinc district, by M. H. Newman, are included in the guidebook on mining districts of the Eastern States.

Work in the southern Appalachian region is noted under Alabama.

TEXAS

L. W. Stephenson collected additional material in the field from the Navarro formation of Texas, including many new species and some new genera, which will necessitate revision of the manuscript for the monograph on the Navarro fossils of Texas that is being prepared in cooperation with the Texas Bureau of Economic Geology.

Julia Gardner continued preparation of the monograph on the Midway fauna of Texas, a cooperative project with the Texas Bureau of Economic Geology, which is about complete and will be published as a bulletin of the University of Texas.

Field work in southern Texas was continued by Miss Gardner in connection with the studies of the Eocene formations of the State. In cooperation with the water-resources branch Miss Gardner studied the Lower Tertiary formations of southern Texas and C. W. Cooke made field studies in the vicinity of Houston.

The geologic map of Texas, which has been compiled by N. H. Darton, L. W. Stephenson, and Julia Gardner in cooperation with the Bureau of Economic Geology of Texas and several oil companies and other geologists, has been so far completed as to be ready for the issuance of a preliminary uncolored edition, as a basis for criticism and revision.

The geology of the Marathon Basin, including the Monument Springs and Marathon quadrangles, will be discussed by P. B. King in a report for Survey publication on which work has been advanced during the year. Mr. King, assisted by J. B. Knight, continued the field study of the geology of the Diablo Plateau area. As a by-product of his investigations in western Texas, Mr. King wrote for unofficial publication the following papers: "Limestone reefs in the Leonard and Hess formations," *American Journal of Science*; "Possible Silurian and Devonian strata in the Van Horn region," *Bulletin of the American Association of Petroleum Geologists*; "Large boulders of the Haymond formation of west Texas," and "Permian limestone reefs in the Van Horn region of Texas," *Bulletin of the Geological Society of America*; and an abstract of a paper on Paleozoic folding in trans-Pecos Texas, for the *American Association of Petroleum Geologists*. The last-mentioned paper will be revised and enlarged for Survey publication.

The manuscript of a report on the geology of the Rio Grande region of Texas, by A. C. Trowbridge, was revised, additional data by L. W. Stephenson and Julia Gardner were included, and the paper was transmitted for publication as a bulletin of the Survey.

The coastal terraces of Texas will be described in a paper which C. W. Cooke is preparing on the coastal terraces of the Atlantic and Gulf States.

In connection with studies of organic constituents of sediments from some American oil fields, P. D. Trask, assisted by W. R. Keyte for the American Petroleum Institute, visited the eastern Texas oil field to procure samples.

A paper by Josiah Bridge and C. L. Dake, entitled "The subdivision and correlation of the Ellenburger limestone" was submitted for publication in the *Bulletin of the Geological Society of America*.

A cooperative investigation including field mapping of the structure of the Cliffside dome and surrounding area in Potter County was made by N. W. Bass for the Bureau of Mines, and the report was completed and sent to that bureau.

A paper by F. S. MacNeil on a new genus of fresh-water mussels from the Catahoula sandstone of Texas was approved for publication in the *Bulletin of the American Association of Petroleum Geologists*.

Study of the Ostracoda of the Marble Falls limestone was continued by P. V. Roundy.

A guidebook on western Texas and the Carlsbad Caverns was written by N. H. Darton, P. B. King, and B. H. Haigh, Mr. Darton having prepared the part relating to the Guadalupe Mountains, Carlsbad Caverns, and El Paso region, and Messrs. King and Haigh the portions on the Marathon and Glass Mountains, Diablo Plateau, and Hueco Mountains. A guidebook on the petroleum geology and stratigraphy of Oklahoma and Texas was prepared under the direction of W. E. Wrather, and one on the Pennsylvanian of the northern mid-continent region by R. C. Moore.

Work on potash is described on pages 11-13, and several projects including work in Texas are noted under Arkansas and Louisiana.

UTAH

A. Baker, assisted by D. A. Andrews and party, continued detailed areal structural mapping in the southern part of the Green River Desert in Garfield and Wayne Counties.

Reports for Survey publication on the geology of the Salt Valley anticline and northwestern flank of the Uncompahgre Plateau, Grand County, by C. H. Neale, and one on the Monument Valley-Navajo region of San Juan County, by A. Baker, are nearly completed. Mr. Baker continued office work on his report on the geology of the Green River Desert and the eastern flank of the San Rafael Swell. The report on the geology and oil possibilities of the southern part of the Moab district, Grand and San Juan Counties, was completed by Mr. Baker for publication as a bulletin of the Survey.

L. M. Spleker extended his field mapping and study of the coals, stratigraphy, and structure of a portion of the Wasatch Plateau and continued office work on reports in hand covering his investigations of several seasons in this region, which will include a paper on coal resources, a discussion of the glacial geology, and a professional paper on the general geology and mineral resources of the region.

F. E. Gregory did field work in the Colorado Plateau region of southern Utah in connection with gathering material for a guidebook and in furthering his studies on correlation of the geologic formations of this region.

A paper by R. W. Brown on recognizable species of the Green River flora of Colorado, Utah, and Wyoming was completed for inclusion in "Shorter contributions to general geology."

The report on the geology of the portion of the Book Cliffs, Utah, between Monticello and the Colorado State line, by D. J. Fisher, was transmitted for publication as a bulletin of the Survey.

The report on the geology and ore deposits of the Gold Hill quadrangle by B. Nolan is nearly completed.

Edwin Kirk completed the draft of a paper on the Eureka quartzite of the Great Salt Lake Basin.

Studies of the species of *Tempyskya* from the Cretaceous and Upper Jurassic formations are being made by R. W. Brown and C. B. Read.

A guidebook on the Great Salt Lake region, prepared under the direction of A. M. Boutwell, contains the following papers:

Geography, by J. C. Alter.

Geomorphology, by W. M. Davis.

Stratigraphy, by A. A. L. Mathews.

Geologic structure and geologic history, by Paul Billingsley.

Economic geology, by J. M. Boutwell.

Wasatch front, by J. M. Boutwell.

Bingham mining district, by R. N. Hunt.

Stratigraphy in the central Wasatch and western Uinta Mountains, by J. M. Boutwell.

Park City mining district, by J. M. Boutwell.

Cottonwood region, by J. M. Boutwell.

Mount Timpanogos, by M. O. Hayes.

Tintic mining district, by Paul Billingsley and G. W. Crane.

Salt Lake City to Montpelier, Idaho, by G. R. Mansfield.

The dinosaur quarry of eastern Utah, by F. J. Pack.

A guidebook on the Colorado Plateau region was prepared by H. E. Gregory. Correlation of the Jurassic sandstone is noted under Arizona, work in the Ogden Basin under Wyoming, and work in the Rocky Mountain phosphate fields under Idaho. Work on potash in Utah is described on page 12.

Publications: Professional Papers 164 and 168. (See p. 1.)

VERMONT

Arthur Keith contributed corrections and revisions of the geologic boundaries of Vermont for the geologic map of the United States.

A guidebook by C. R. Longwell and others, covering eastern New York and western New England, includes descriptions of geologic features in western Vermont, by Mr. Keith and E. B. Knopf. A paper on the stratigraphy and structure of northwestern Vermont by Mr. Keith was approved for publication in the Washington Academy of Sciences.

Work in the Taconic quadrangle is noted under Massachusetts.

VIRGINIA

The field work in the study of the geology of the southwestern Virginia zinc and lead region carried on by L. W. Currier in cooperation with the Virginia Geological Survey was completed, and the report, which will be published by the State, is about ready for transmittal.

Areal mapping of the Appalachian Valley of Virginia by Charles Butts, a project which has been under way for several years in cooperation with the Virginia Geological Survey, was completed, and the manuscript geologic map was finished by Mr. Butts and transmitted to the State geologist for publication.

Field work in the Abingdon quadrangle is in progress by Mr. Butts in cooperation with the State. This work comprises revision and completion of work started by G. W. Stose several years previously.

E. O. Ulrich and Josiah Bridge made field examinations of outcrops of some early Paleozoic formations to gather data for their general studies of the early Paleozoic gastropods in North America. J. S. Williams made a brief field study of Carboniferous formations in the southern part of the State.

A field study of the titanium deposits was made by C. S. Ross in connection with his work on the southern Appalachian copper deposits.

A guidebook to the Chesapeake Bay region was prepared by L. W. Stephenson, C. W. Cooke, and W. C. Mansfield, and a guidebook to northern Virginia, prepared under the direction of Arthur Bevan, includes the following papers:

Introduction, by Arthur Bevan.

Geomorphology of the Piedmont region, including The composite plain of the Virginia Piedmont, by M. R. Campbell, and Itinerary, by Arthur Bevan.

Charlottesville to West Virginia by way of Waynesboro, Staunton, and Monterey, by Charles Butts, including Pre-Cambrian, by A. I. Jonas.

Titanium deposits of the Roseland district, by C. S. Ross.

Talc and soapstone deposits of Virginia, by J. D. Burfoot, jr.

WASHINGTON

Some progress was made by W. C. Alden on the report on the glacial geology and geomorphology of eastern Washington.

A brief examination of the Metaline mining district was made by J. T. Pardee. He also prepared reports for the conservation branch on the geology of dam sites on the South Fork of the Nooksack River and the Queets River and near Ray's Ferry and examined for the water-resources branch ground-water occurrences at the Puget Sound Navy Yard.

E. W. Berry studied fossil plants from the Latah formation of Grand Coulee.

A guidebook on the channeled scabland was prepared by J. H. Bretz.

Publication: Professional Paper 170-C. (See p. 2.)

WEST VIRGINIA

Work on the Lower Kittanning coal beds is noted under Pennsylvania.

WISCONSIN

A guidebook on the glacial geology of the Central States, prepared under the direction of W. C. Alden, contains an annotated guide of southern Wisconsin, by E. F. Bean, F. W. Thwaites, and W. C. Alden. The guidebook on the Lake Superior region, with an introduction by C. K. Leith, contains papers on the Gogebic range, by W. O. Hotchkiss; mining in the Gogebic range, by F. G. Pardee; and Gogebic range to Duluth, by H. R. Aldrich.

Work in the Lake Superior iron-ore region is noted under Minnesota.

WYOMING

The detailed geologic field study of phosphate occurrences in the Afton quadrangle was continued by W. W. Rubey and J. S. Williams, and a conference in the quadrangle was held with G. R. Mansfield. Several more seasons will be required to complete the field work. Paleontologic studies on Ordovician and Devonian fossil collections were made by Edwin Kirk.

Reports for Survey publications are in preparation by W. H. Bradley on the geomorphology of the north flank of the Uinta Mountains and on Tertiary rocks of the Green River Basin.

Samples from wells in and around the Salt Creek oil field were collected by P. D. Trask for study in connection with his work on organic constituents of sediments from four American oil fields.

R. W. Brown completed a paper on fossil plants from the Aspen shale in southwestern Wyoming for publication in the Proceedings of the United States National Museum.

Mr. Brown and C. B. Read collected data on *Tempskya* from the Cretaceous and Upper Jurassic rocks with particular reference to the Wayan and Aspen formations of southwestern Wyoming.

G. R. Mansfield made a geologic examination and prepared a report for the conservation branch on dam sites in the canyon of the South Fork of the Snake River.

A guidebook to the Yellowstone-Beartooth-Big Horn region, prepared under the direction of R. M. Field, contains the following papers:

Introduction, by W. T. Thom, jr.

Stratigraphy, by J. G. Bartram.

Regional structural relations, by W. T. Thom, jr., R. T. Chamberlin, and W. H. Bucher.

Geologic history, by Arthur Bevan, Elliot Blackwelder, N. M. Fenneman, R. M. Field, and W. T. Thom, jr.

Yellowstone National Park, by R. M. Field.

Hot Springs of Yellowstone Park, by E. T. Allen.

Mammoth Hot Springs to Grand Canyon of the Yellowstone, by R. M. Field.

Grand Canyon of the Yellowstone to Roosevelt Lodge, by R. M. Field.

Roosevelt Lodge to east entrance of Yellowstone Park, by R. M. Field.

East entrance of Yellowstone Park to Cody, by W. T. Thom, jr., R. M. Field, R. T. Chamberlin, and W. H. Bucher.

Cody to Red Lodge, by W. T. Thom, jr., R. T. Chamberlin, W. H. Bucher, W. J. Sinclair, and G. L. Jepsen.

Red Lodge area, by N. M. Fenneman, Erling Dorf, W. J. Sinclair, and G. L. Jepsen.

Red Lodge to Beartooth Butte and return, by Arthur Bevan and Erling Dorf.

Red Lodge to Billings by way of Pryor Gap, by W. T. Thom, jr., N. M. Fenneman, R. T. Chamberlin, and W. H. Bucher.

Pryor Gap to Sheridan, by R. T. Chamberlin, W. H. Bucher, and W. T. Thom, jr.

Paleocene and Eocene formations and faunas of the northern part of the Big Horn Basin, by W. J. Sinclair and G. L. Jepsen.

History of petroleum development in the Big Horn Basin region, by W. B. Emery.

Gravity data, by William Bowie.

Other work in Wyoming is noted under Colorado, Idaho, and North Dakota.

MISSISSIPPI VALLEY

Investigation of the geomorphic history of the head of the Mississippi embayment was continued by F. E. Matthes. This included studies of the uplands from the vicinity of Poplar Bluff to Cape Girardeau, Mo., thence south to New Madrid, Mo., and in the vicinity of Reelfoot Lake, Tenn. Mr. Matthes has made progress on his report on diversion of the Mississippi River across Crowley's Ridge.

FOREIGN COUNTRIES

E. O. Ulrich and Josiah Bridge made brief field examinations of fossil localities in eastern Canada in connection with their studies of fossil distribution in North America. C. B. Read prepared a paper on new species of *Dadoxylon* from the Permian of Shensi, China. A paper by C. W. Cooke entitled "Why the Mayan cities of the Peten district, Guatemala, were abandoned" was published in the Journal of the Washington Academy of Sciences. Cooperation with the National Research Council was given by Julia Gardner in a study of Mexican Tertiary fossils. Fossil collections from Bolivia, Brazil, and Puerto Rico were reported upon by Edwin Kirk and J. B. Reeside, jr.

GENERAL STUDIES

Mineralogic, structural, stratigraphic, and paleontologic studies of a general nature or covering broad areas have been carried on during the year by many of the geologists. These include studies on the source rocks of petroleum, by P. D. Trask, in cooperation with the American Petroleum Institute; origin

and constitution of coal and carbonaceous shale, by Taisia Stadnichenko; classification of coals, by David White and M. R. Campbell; copper deposits of the southern Appalachian region, by C. S. Ross; structural relation of lead and zinc deposits in the Appalachian belt, by L. W. Currier; structural geology of the Great Basin, by D. F. Hewett; occurrence of manganese in the United States, by D. F. Hewett; early Paleozoic gastropods, by E. O. Ulrich and Josiah Bridge; early Paleozoic cephalopods, by E. O. Ulrich, A. F. Foerste, and Josiah Bridge; lower Paleozoic stratigraphy of the upper Mississippi Valley, by E. O. Ulrich; Maquoketa fauna of the Mississippi Valley, by E. O. Ulrich and A. F. Foerste; Upper Cretaceous Foraminifera of the Gulf Coastal Plain, by J. A. Cushman and L. G. Henbest; Devonian-Carboniferous faunas, by G. H. Girty; the genus *Productus*, by G. H. Girty and J. S. Williams; the Ostracoda and Carboniferous microfossils, by P. V. Roundy; a new genus of Cycadofilicales, by C. B. Read; *Rototinnula*, a new genus of fossil plants from the upper Paleozoic, by C. B. Read; the Jackson group, by C. W. Cooke; and Pleistocene shore lines by C. W. Cooke. E. F. Burchard compiled data on the fluorspar deposits in the western United States for use by the Bureau of Mines. F. E. Matthes prepared for the National Research Council committee on sedimentation a paper on glacial sediments in the Mississippi Valley.

The following papers giving results of general studies were completed during the year for publication by the Geological Survey:

Cushman, J. A., Upper Eocene Foraminifera of the southeastern United States (professional paper).

Cushman, J. A., and Cahill, E. C., Miocene Foraminifera of the Coastal Plain of the eastern United States (Shorter contributions to general geology).

Howe, M. A., The geologic importance of the lime-secreting algae, with a description of a new travertine-forming organism (Shorter contributions to general geology).

King, P. B., Structural geology of the United States (International Geological Congress guidebook).

Reeside, J. B., jr., Stratigraphic nomenclature in the United States (International Geological Congress guidebook).

The following papers were completed or published in technical journals:

Anderson, A. L., Notes on the oxidation of jamesonite, sphalerite, and tetrahedrite. *Economic Geology*.

Anderson, A. L., Occurrence of giant hornblende. *Journal of Geology*.

Brown, R. W., A Cretaceous sweet gum. *Botanical Gazette*.

Butler, B. S., Influence of the composition of the replaced rock on the minerals formed in metasomatic replacement associated with ore deposits. *Economic Geology*.

Campbell, M. R., Coal work carried on by the Geological Survey. *United States Daily*.

Cooke, C. W., Tentative correlation of American glacial chronology with the marine time scale. *Journal of the Washington Academy of Sciences*.

Cooke, C. W., The seven coastal terraces in the Southeastern States. *Journal of the Washington Academy of Sciences*.

Gardner, Julia, and Bowles, Edgar, The distribution of the *Venericardia planicosta* group in the American lower Eocene. *Journal of Paleontology*.

Gardner, Julia, and Bowles, Edgar, An inverted hinge in a left valve of the *Venericardia planicosta* group. *Journal of Paleontology*.

Girty, G. H., New Carboniferous invertebrates. *Journal of the Washington Academy of Sciences*.

Goldman, M. I., Discussion of authors' abstracts. *Science*.

Henbest, L. G., The species *Endothyra baileyi* (Hill). *Contributions from the Cushman Laboratory*.

Jonas, A. I., Structure of the metamorphic belt of the southern Appalachians. *American Journal of Science*.

Loughlin, G. F., Nonferrous metal deposits. *United States Daily*.

Lovering, T. S., Field evidence to distinguish overthrust from underthrusting. *Journal of Geology*.

Mansfield, G. R., Remarkable luxuriance of marine vegetation in early geologic time. *Science Service*.

Matthes, F. E., Matthes's studies in the Mississippi Valley (summer of 1932). *Journal of Geography*.

Matthes, F. E., Mountain glaciers and their work. *Home Geographic Monthly*.

Miser, H. D., Geologic studies of petroleum, natural gas, and helium. United States Daily.

Ross, C. S., Clay minerals. American Ceramic Society.

Rubey, W. W., Settling velocities of gravel, sand, and silt particles. American Journal of Science.

Shenon, P. J., Chalcopyrite and pyrrhotite inclusions in sphalerite. American Mineralogist.

Shenon, P. J., A massive sulphide deposit of hydrothermal origin in serpentine. Economic Geology.

Shenon, P. J., A curious occurrence with platinum. Engineering and Mining Journal.

Cushman, J. A., The Foraminifera of the Saratoga chalk. Journal of Paleontology.

Trask, P. D., Origin and environment of source sediments; Summary of work of 1931-32. American Petroleum Institute.

Trask, P. D., Deposition of organic matter in recent sediments. American Association of Petroleum Geologists.

Trask, P. D., Relation of calcium carbonate content of sediments to salinity of the surface water (abstract presented at Tulsa meeting). Geological Society of America.

Williams, J. S., and Rowley, R. R., Unique coloration of two Mississippian brachiopods. Journal of the Washington Academy of Sciences.

Contributions of general scope for the Lindgren volume of the American Institute of Mining and Metallurgical Engineers include the following papers:

Ore deposits as related to stratigraphy, structure, and igneous geology in the western United States, by B. S. Butler.

Manganese in western hydrothermal deposits, by D. F. Hewett and J. T. Pardee.

Mesothermal tungsten deposits of the western United States, by T. S. Lovering.

Pre-Cambrian iron ores, by T. S. Lovering; Mesothermal silver-lead-zinc veins, by E. T. McKnight.

Epithermal precious-metal deposits of the Western States, by T. B. Nolan.

Epithermal quicksilver deposits of the Cordilleran region, by C. P. Ross.

Antimony, by F. C. Schrader.

Molybdenum, by J. W. Vanderwilt.

Publications: Professional Paper 170-B; Bulletin 838. (See p. 2.)

WORK IN PETROLOGY

The work in petrology comprises three distinct phases—the preparation of thin and polished sections of material to be studied under the microscope, the study and identification of rocks and minerals, and the application of petrographic methods to geologic problems.

The grinding laboratory of the section of petrology during the year made 2,501 thin sections, polished 477 specimens, and sawed 77 specimens. Of these about 100 thin sections and 75 polished specimens were of coals, which present unusual difficulties in the production of specimens satisfactory for microscopic study. Over 500 thin sections were of clay, soils, friable sands, and salt, all of which require special technic in preparing.

A large portion of the time of the section of petrology is devoted to the determination of rocks submitted to the Geological Survey by people throughout the country, by oil geologists, and by those interested in mining, and in cooperative work with various States.

J. J. Glass calibrated the materials for 35 sets of index of refraction media for use by geologists, aided in the identification of specimens, and partly completed a detailed study of two pegmatites near Amelia, Va., and of the optical properties of the mineral inesite.

A paper on the manganese minerals of a vein near Bald Knob, N. C., by Clarence S. Ross and Paul F. Kerr, was published in the American Mineralogist.

WORK IN CHEMISTRY AND PHYSICS

The work in chemistry and physics includes tests necessary for the determination of rocks, ores, and minerals collected or received by the Geological Survey, qualitative and quantitative analyses of specimens and samples collected by geologists, and researches relating to problems in geology on which the Geological Survey is engaged.

Work in connection with the special 5-year appropriation for potash investigations is described on pages 11-13. W. T. Schaller has partly prepared a report on the mineralogy of the mine of the United States Potash Co., near Carlsbad, N. Mex. Chemical analyses of potash samples were made by R. K. Bailey, L. T. Richardson, E. T. Erickson, and J. J. Fahey. Some well logs were made by R. K. Bailey in Roswell, N. Mex., and others after he returned to Washington. A few cores were examined petrographically by Mr. Fahey, but most of the petrographic work on potash was done by F. C. Calkins. For several wells Mr. Calkins has edited all available information, consisting of different reports by himself, permittees, chemists, petrographers, and geologists, and combined it into a single report for each well.

Three lines of investigation were carried on by P. G. Nutting—(1) determination of the porosity and permeability of oil sands, (2) thermal dehydration of different minerals, and (3) study of the absorptive power of clays as determining their capacity to bleach or clarify oils. This property of clays seems to indicate distinct differences in their chemical and physical make-up, but it is too soon yet to say exactly what constituents or structures give the clays the properties observed.

C. E. Van Orstrand made temperature tests in deep wells in California, Michigan, Kentucky, and West Virginia. As a result of his discovery several years ago of a variation of temperature with structure in several oil fields, chiefly in Wyoming, the American Petroleum Institute initiated a research on the subject extending over a period of five years. The field work has been completed, and several reports on the subject have been published. In the office Mr. Van Orstrand studied special theoretical problems on the flow of heat in the crust of the earth. He was assisted in this research by H. C. Spicer, who carried out an elaborate series of computations on the flow of heat from dikes and other geologic features.

Identifications of specimens sent in by persons not officially connected with the Survey were made up to October 1, 1931, largely by L. T. Richardson, and after that date by Charles Milton, who also assisted in the chemical analysis of a number of minerals and rocks from different localities. A large number of rock analyses for geologists were made by J. G. Fairchild, assisted by E. T. Erickson, J. J. Fahey, R. E. Stevens, George Steiger, and R. O. Wells. Mr. Fairchild also analyzed several rare minerals, including thorianite from a locality near Easton, Pa., samarskite from South Carolina, pitchblende from Colorado, inesite from Oregon, and siderite from France.

Work with the quartz spectrograph occupied most of George Steiger's time. Technic was further developed so that a fair number of elements could be quickly detected, at least qualitatively. In this way over 150 analyzed samples were tested for beryllium, and the percentages of the six platinum metals in crude platinum ore were estimated. E. T. Erickson made qualitative tests for platinum metals, bromine, boron, and iodine in different ores and salines.

Among the rocks analyzed in the laboratory were 14 lavas and tuffs from Hawaii, 7 greenstones and 16 diatomites from Oregon, 24 dolomites from Colorado, 7 manganese ores from Arkansas, and 14 clays from different localities.

R. E. Stevens made experiments relating to theories of ore genesis and the solution of silicate rocks in water, with special reference to the alkalinity of such solutions. In particular he studied the action of alkali sulphide solutions on pyrite and analyzed an unusual silver and bismuth bearing galena from Leadville.

The age of minerals, as indicated by the lead-uranium ratio, was studied by R. C. Wells, collaborating with the National Research Council committee on the measurement of geologic time. Analyses for this purpose were also made by J. G. Fairchild, J. P. Marble, who had determined the atomic weight of lead in pitchblende from the Great Bear Lake region of Canada at Harvard University, analyzed different samples of the same material in the Geological

Survey laboratory to ascertain if the different deposits of that region have the same or different ages.

J. J. Fahey studied the optical, physical, and chemical properties of serpentines from several localities, collaborating with P. F. Kerr, of Columbia University, who is making X-ray studies of them. He also analyzed apthitalite from New Mexico.

E. T. Erickson determined a number of natural bitumens and familiarized himself with paleobotany, with special reference to possible chemical changes in the alteration of plant tissues in the formation of bitumen, oil, and coal.

Much of Mr. Schaller's time was taken up in consultations with geologists concerning their mineralogic problems. He critically read more than a dozen referred manuscripts and gave eight lectures during the year—one at Spruce Pine, N. C., and most of the others in New York City at Columbia University, the American Institute of Mining and Metallurgical Engineers, and the New York Mineralogical Club. He spent a few days in field work in North Carolina and Virginia. A set of commercial soapstones was studied mineralogically, showing that talc is only a minor constituent. A study of an unknown manganese silicate from Oregon and from Italy showed it to be a new member of the pyroxene group.

During the year 5,814 examinations were made, of which 2,339 were petrographic or microscopic identifications of the potash minerals in cores and well cuttings. The potash work also required 1,187 qualitative tests and 441 quantitative analyses. Identifications of specimens made in the chemical laboratory for persons not connected with the Survey amounted to 1,173. The remaining 460 qualitative tests and 214 quantitative analyses were made chiefly in response to direct requests by geologists and partly in connection with chemical and physical researches relating to methods of analysis and geochemical studies.

The following papers were completed during the year:

- Buddington, A. F., and Fairchild, J. G., Tertiary volcanics of southeastern Alaska. *American Journal of Science.*
 - Hess, F. L., and Fahey, J. J., Cesium biotite from South Dakota. *American Mineralogist.*
 - Milton, Charles, The occurrence of moissanite in sediments. *Journal of Sedimentary Petrology.*
 - Nutting, P. G., Physical and chemical factors in the accumulation and discharge of oil. *American Association of Petroleum Geologists.*
 - The bleaching clays. *United States Geological Survey.*
 - The solution and colloidal dispersion of minerals in water. *Journal of the Washington Academy of Sciences.*
 - The bleaching earths. *Industrial and Engineering Chemistry.*
 - Schaller, W. T., Sulvanite from Utah. *American Mineralogist.*
 - Refractive indices of bloedite. *American Mineralogist.*
 - Schaller, W. T., and Fairchild, J. G., Bavenite from California. *American Mineralogist.*
 - Shenon, P. J., and Steiger, George, A curious occurrence of platinum. *Economic Geology.*
 - Stevens, B. E., Studies on the alkalinity of some silicate minerals. *United States Geological Survey.*
 - The formation of pyrrhotite by the action of alkali sulphide solutions on pyrite. *Economic Geology.*
 - Van Orstrand, C. E., The precision analysis of gaseous hydrocarbons and other gases by the heat conduction method. *American Petroleum Institute.*
 - Discussion of F. W. Lee's paper on "A comment upon present-day applied geophysics." *American Gas Association.*
 - Some recent applications of physics to sedimentation problems. *National Research Council.*
 - The correlation of isogeothermal surfaces with the rock strata. *Physics.*
 - Wells, R. C., and Stevens, R. E., Further studies of kolm. *Journal of the Washington Academy of Sciences.*
- Publications: *Bulls.* 832, 833. (See p. 2.)

ALASKAN BRANCH

PHILIP S. SMITH, Chief Alaskan Geologist

ORGANIZATION AND PERSONNEL

The Alaskan branch consisted at the end of the year of the chief Alaskan geologist, 6 geologists, 1 mining engineer, 1 coal-mining assistant, 5 topographic engineers, 1 draftsman, and 4 clerks. In addition, 12 camp hands and other assistants were employed for temporary field service.

SCOPE OF THE WORK

For more than 30 years the Government has been carrying on investigation of the mineral resources of the Territory of Alaska, not only to find out what it owned but also to advise its citizens as to the conditions that were considered favorable for finding deposits of minerals that are of commercial value. This work has been largely carried on through the Alaskan branch of the Geological Survey, and hundreds of reports and maps of the investigations of this unit have been published and made available to all who are interested in the development of the Territory. The work on which these reports are based has taken the geologists and engineers into all parts of the Territory and to all the known important mining camps. Their trails and maps have frequently been the only authoritative guides to many of the remote districts.

The Geological Survey's Alaskan work has two rather distinct phases—one of a general investigational type and the other of a semiadministrative type in connection with the technical supervision of the leases granted by the Government covering coal, oil, or other mineral lands. For convenience of description the work of the first type will be referred to briefly as work on mineral resources and that of the second type as leasing work.

MANUSCRIPTS AND PUBLICATIONS

The principal products of the Alaska work of the Geological Survey are the reports and maps based on original surveys or investigations. During the year 11 such reports and 6 new maps have been issued. (See pp. 1-3.) At the end of the year 28 reports and 8 maps were in different stages of preparation, not including several manuscripts that will require further field work or extensive research before they can be completed. Fifteen short papers were published as press bulletins.

Besides the official reports, several articles were prepared by the scientific and technical members of the branch for publication in outside journals, and 24 public lectures were given regarding the general work of the branch or some of its special features. Most of these were prepared unofficially but represent by-products of the regular work and serve to reach special audiences not readily reached by the official publications.

WORK ON MINERAL RESOURCES

PROJECTS IN PROGRESS DURING THE SEASON OF 1931

In addition to the routine duties of administration and of supplying information in answer to hundreds of inquiries received from the public and from other branches of the Government, 11 principal

projects, 8 of which involved field work, were carried on during the season of 1931. The eight projects involving field work were reconnaissance topographic mapping in the vicinity of Wrangell, southeastern Alaska, by R. H. Sargent, assisted by V. S. Seward; mineral investigation in the Taku district, southeastern Alaska, by B. D. Stewart; geographic and geologic investigations in the vicinity of Glacier Bay, southeastern Alaska, by C. W. Wright and H. F. Reid, whose salaries were paid through the generous cooperation of the Bureau of Mines; geologic and mineral-resources investigations in the Alaska Range province, at the head of the Copper River Valley, especially in the vicinity of Suslota Pass, by F. H. Moffit; reconnaissance topographic mapping in the vicinity of Tonsina, in the central part of the valley of the Copper River, by C. F. Fuechsel; a combined topographic and geologic reconnaissance of part of the Nushagak region, southwestern Alaska, by Gerald FitzGerald and P. A. Davison; mineral-resources investigations in the Rampart-Hot Springs district, of the Yukon region, in central Alaska, by J. B. Mertie, jr.; and a general reconnaissance of recent mining developments, particularly in central Alaska, by Philip S. Smith. In the course of the summer the Director of the Geological Survey, who had been a member of several of the pioneer Survey parties in remote parts of Alaska about 30 years before, joined Mr. Smith in going over the work in progress in the Willow Creek, Anthracite Ridge, Matanuska, and Fairbanks districts.

Some of the results of the season's work on the field projects described in the foregoing paragraphs, as well as that done in earlier years, may be expressed in terms of the area covered. In the following table the areas reported are based on the field season and not on the fiscal year, and therefore no account is taken of the work that was started during the field season of 1932 but remained uncompleted at the end of the fiscal year 1932, in part because at the end of the fiscal year most of the field parties are out of communication and so can not report how much they have accomplished. The areas credited in the table to 1931 include those surveyed in cooperation with the Alaska Railroad (see pp. 39-42) as well as those surveyed in the course of the regular work on mineral resources.

Areas surveyed by Geological Survey in Alaska, 1898-1931, in square miles

Season	Geologic surveys			Topographic surveys		
	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)
1898-1930.....	75,650	176,680	4,277	55,630	213,249	4,066
1931, revision.....		1,936	51		1,024	13
1931.....	75,650	174,695	4,226	55,630	212,225	4,066
		5,656	320		8,873	307
Percentage surveyed of total area of Alaska.....	75,650	180,351	4,546	55,630	217,598	4,380
	44.4			47.3		

In the table given above only the net areas surveyed are listed in the appropriate columns.

As a result of the photographing expeditions of the Navy Department in 1926 and 1929, the Geological Survey has in its files tens of

thousands of photographs taken specially for map-making purposes. Owing to the lack of funds little more compilation is undertaken at present than is required to furnish the ground parties with bases on which to do their field work. Fortunately, however, the records are permanent, so that ultimately all of this material will be used. A little more than 1,000 square miles of new drainage base was compiled from these photographs during 1931. This covered part of the region north and west of Wrangell, in southeastern Alaska, and was prepared for one of the topographic projects for the season of 1932. The map compilation was in charge of R. H. Sargent, who was assisted by V. S. Seward and J. I. Davidson.

The statistics regarding the output of minerals from Alaska each year are derived from many sources, including other Government organizations, such as the Bureau of Mines, the Bureau of the Mint, and the Customs Service; banks, express companies, and other organizations conducting business in Alaska; the larger Alaska newspapers, as well as certain papers published in the States that feature Alaska matters; and the replies to hundreds of schedules, one of which is sent to each person or company that is known to be engaged in mining in Alaska. The general clerical work on the collection of the statistical data for 1931 was carried on by Mrs. L. N. Eaton, and the material was coordinated and the resulting report prepared by the chief Alaskan geologist.

The Geological Survey maintains in Alaska two district offices, one at Juneau and one at Anchorage. The main duties of the personnel attached to these offices relate to mineral leasing (see p. 42), but a part of their service relates to general investigations of mineral resources. The service of one of the staff at the Anchorage office is confined primarily to studies of deposits that may afford tonnage to the Alaska Railroad. This cooperative work was done by Ralph Tuck, and his salary and expenses were paid from railroad funds. (See p. 41.) Approximately two-fifths of the time of B. D. Stewart, supervising mining engineer, with headquarters in Juneau, is allotted to general investigations of mineral resources, including visits to different parts of the Territory as conditions warrant. The Alaska offices also act as local distributing points for publications of the Geological Survey and assist the main office at Washington by furnishing information on many phases of the mineral industry of the Territory.

PROJECTS FOR THE SEASON OF 1932

Ten projects chargeable to funds appropriated directly to the Geological Survey have been approved for the season of 1932. Seven of these projects involve field work and comprise reconnaissance topographic mapping in the Wrangell district and neighboring parts of southeastern Alaska, by R. H. Sargent, assisted by V. S. Seward; mining studies in the Taku district near Juneau and at other points in southeastern Alaska, by B. D. Stewart; reconnaissance topographic surveys in the mountains at the head of the Copper River Valley and at isolated unmapped tracts adjacent to the Richardson Highway between Valdez and Chistochina, by C. F. Fuechsel; reconnaissance geologic surveys in the Tonsina district, in the west-central part of the valley of the Copper River, by F. H. Moffit; reconnaissance topographic mapping of the northern part of Kodiak Island and adjacent islands in southwestern Alaska, by Gerald FitzGerald;

a geologic reconnaissance of parts of the Aleutian Islands, by S. R. Capps, in connection with an expedition sent by the Navy Department into that region; and the usual general studies of recent mining developments throughout Alaska, by Philip S. Smith.

A project that does not directly require field work for its completion, though it is based primarily on the field work that has been done in the past, is the preparation of a comprehensive report on the large tract of country lying west of the international boundary and included between the Yukon and Tanana Rivers. Ever since the earliest investigations of Alaska's mineral resources by the Geological Survey its parties have traversed parts of this region. To digest the mass of material resulting from these investigations and to bring forth a comprehensive and well-coordinated report that will present the best current interpretation of the complex geologic history of the region is the object of this undertaking. The task has been assigned to J. B. Mertie, jr., who during nine seasons has done field work in different parts of this region.

EXPENDITURES

The following table shows the principal classes of expenditures for which the appropriation for the fiscal year 1931-32 was allotted:

Approximate expenditures from funds appropriated for investigation of mineral resources of Alaska for the fiscal year 1931-32

Projects for the season of 1931-----	\$22, 190
Projects for the season of 1932-----	11, 100
Administrative salaries, July 1, 1931, to June 30, 1932-----	4, 970
All other technical and professional salaries, July 1, 1931, to June 30, 1932-----	32, 930
All other clerical and drafting salaries, July 1, 1931, to June 30, 1932-----	8, 710
Office maintenance and expenses-----	3, 900
Balance and contingent-----	700
	<hr/>
	84, 500

Of the \$33,290 allotted to field projects about 45 per cent was allotted to geologic or related general work and 55 per cent to topographic work.

COOPERATIVE WORK WITH THE ALASKA RAILROAD

According to its organic act, the construction of the Alaska Railroad was undertaken not so much to enter the business of common carrier as to develop the Territory. However, the excess of expenses over income was large, and in 1929 Col. O. F. Ohlson, the manager of the railroad, requested aid from the Geological Survey to determine what could be done to stimulate mineral development that might contribute tonnage to the railroad, but with the funds and personnel available only a little work was actually accomplished. In 1930 a senatorial committee visited Alaska with the prime purpose of seeing what could be done to decrease the deficit of the Alaska Railroad, and in 1931 an appropriation of \$250,000 was granted by Congress for the "continuation of the investigation of mineral and other resources of Alaska to ascertain the potential resources available which will affect railroad tonnage." The Geological Survey was asked to submit recommendations as to the areas that appeared desirable to examine under this grant and to direct the technical work through its trained personnel.

PROJECTS IN PROGRESS IN 1931

Ten projects were approved for the season of 1931, embracing examinations in one coal area (Anthracite Ridge field), five gold districts (Fairbanks, Willow Creek, Moose Pass, Girdwood, and Valdez Creek), and three areas where the lodes consist mainly of mixed sulphides (the Eureka area in the Kantishna district, Mount Eielson, and an area near the head of the West Fork of the Chulitna River), and a general investigation of potential nonmetalliferous deposits throughout the railroad belt. All these areas had already been examined by Survey geologists in a manner that was regarded as adequate for reconnaissance standards, and the new work was to be of a much more detailed and intensive character and was directed toward quantitative determination of possible mineral tonnage rather than more general theoretical studies. The direct oversight of all the parties was assigned to S. R. Capps. During part of the season, through the cooperation of the geologic branch, the services of D. F. Hewett were made available as special consultant, and he visited many of the parties working in metalliferous areas and gave valuable advice and suggestions. Through the courtesy of the Bureau of Mines the samples collected by the different parties were analyzed at the laboratories of the bureau in Alaska. Cooperation was also afforded by the Alaska Road Commission.

The following table presents in condensed form information regarding the various projects:

Projects for cooperative work with Alaska Railroad, 1931

District or area	Principal kind of deposits examined	Types of work	Technical personnel
Anthracite Ridge.....	Coal field.....	Detailed mineral resources and topography (1:12,500).	R. W. Richards, G. A. Waring, L. O. Newcome.
Fairbanks.....	Gold lodes.....	Detailed mineral resources.....	J. M. Hill.
Willow Creek.....	do.....	do.....	J. O. Ray.
Moose Pass-Hope.....	do.....	do.....	Ralph Tuck.
Girdwood.....	do.....	Detailed mineral resources and topography (1:62,500).	W. G. Carson, C. F. Park.
Valdez Creek.....	Gold lodes and placers.....	Detailed mineral resources and reconnaissance topography.	C. P. Ross.
Eureka (Kantishna).....	Gold and mixed sulphides.....	Detailed mineral resources and topography (1:62,500).	F. G. Wells, S. C. Kish.
Mount Eielson.....	Copper, lead, and zinc.....	Detailed mineral resources and topography (1:62,500 and 1:24,000).	S. N. Stoner, J. O. Reed.
West Fork of Chulitna River.....	Gold and mixed sulphides.....	Detailed mineral resources and reconnaissance topography.	C. P. Ross.
General.....	Nonmetalliferous deposits.....	Reconnaissance mineral resources.	G. A. Waring.

PROJECTS IN PROGRESS IN 1932

Of all the projects undertaken in the summer of 1931 probably the most general interest centered around the work in the vicinity of Anthracite Ridge. It was undoubtedly the occurrence in this field of a bed of anthracite nearly 40 feet thick that induced the senatorial committee to take an optimistic view as to the probability of discovering mineral tonnage for the railroad, and the large amount of money recommended by the committee was based on the idea of core drilling this field extensively. The investigation in 1931 showed that the geologic information that could be obtained from surface indications is not adequate as a basis for conclusions and that the best way to determine the real value of the field is by drilling. On January 15, 1932, a contract was awarded to put down four holes to an estimated

depth of 2,000 feet each and to recover the core from them. G. A. Waring was designated as the Geological Survey representative to see that the drilling was carried on in accordance with the specifications and to receive and take care of the core as recovered, and P. A. Davison was assigned as assistant. According to the terms of the contract the driller has until December 31, 1932, to complete the work, but it seems probable that if no unusual difficulties arise the work should be finished considerably before that date.

Another drilling project undertaken in 1932 involves the testing of a coal area west of the present developed part of the Moose Creek field, in the Matanuska Valley, where the geologic conditions suggest that the coals may be less shattered and capable of being more cheaply mined than in the developed area. As the region is heavily covered with glacial deposits, the most suitable method of determining the sequence of beds and their structure is by drilling them and recovering cores of the formations penetrated. The contract has been awarded for drilling four holes, each about 1,000 feet deep and the work is to be completed by December 31, 1932. G. A. Waring, assisted by P. A. Davison, will have general oversight of the Government's interest in this work. The Moose Creek field lies within a few miles of existing transportation lines.

Another means of aiding the railroad in its endeavor to stimulate the production of minerals in the territory adjacent to its line has been the assignment of a geologist to the headquarters of the railroad at Anchorage, so that he might be readily available for consultation both by the officials or by others who wished technical information. This duty has been given to Ralph Tuck, who, during the winter of 1931-32 has made trips throughout the extent of the railroad, made several special examinations, completed a report on the Moose Pass-Hope district, and started a comprehensive file listing all the mineral properties adjacent to the railroad. The cooperative plan contemplates that each year the geologist should spend most of the open season in the examination of some prospective mineral-bearing area whose development might contribute tonnage to the railroad. In the season of 1932 an extensive tract along the eastern flanks of the Alaska Range between Ruth and Eldridge Glaciers will be examined by a combined geologic and topographic party in charge of Ralph Tuck and C. P. McKinley.

EXPENDITURES

An analysis of the expenditures made by the Geological Survey in connection with the projects it has carried on in cooperation with the Alaska Railroad would present only a partial picture of the work, because only such amounts as are needed for direct expenditure by the Geological Survey are transferred to its credit.

In general terms the allotments so far made to the Geological Survey for disbursement during the season of 1931 were approximately \$72,000; the expenses of supervision of the drilling and other Geological Survey work in connection with the Anthracite Ridge and Moose Creek projects until December 31, 1932, are estimated at \$13,800; and the field expenses of the reconnaissance geologic and topographic survey, including all office charges for Mr. Tuck's services until December 31, 1932, are estimated at \$7,000. All these estimates provide only for expenses directly incurred in connection with the projects and do not include any charges for general administra-

tion by the Geological Survey nor any indirect charges for overhead expenses in the Washington office, although the projects have thrown a heavy load on the small regular personnel.

LEASING WORK

Part of the activities of the Alaskan branch are related to the proper conduct of mining work on the public mineral lands that have been or may be leased to private individuals or corporations under certain laws. Funds for this work throughout the United States are provided in a general item contained in the Interior Department appropriation act. For the fiscal year 1932 the allotment for Alaska leasing work was \$8,000.

In order that the policies and practices that have been developed by the leasing unit of the conservation branch of the Geological Survey for handling the much larger volume of similar work in the States should be maintained in Alaska and at the same time the specialized knowledge of Alaskan affairs possessed by the Alaskan branch should be utilized, the general conduct of the leasing work in Alaska is in a measure shared between the two branches, the office work in Washington being done principally by the conservation branch and the field work by the Alaskan branch.

B. D. Stewart, supervising engineer, who has headquarters at Juneau, is in immediate charge of the field work, assisted by J. J. Corey, coal-mining engineer, at Anchorage.

The primary purpose of the leasing work is to supervise the operations under the coal and oil leases or permits that have been granted by the Government and to advise and consult with the proper authorities, both Federal officers and private applicants, regarding lands that may be under consideration for a lease or permit. Practically all the coal mining and much of the oil prospecting in Alaska is done on public lands by private individuals or companies under leases or permits issued by the Secretary of the Interior.

During 1931 the operator of one of the two coal mines in the Matanuska district that had furnished a considerable part of the coal used in the operation of the railroad found it financially impracticable to continue operation and decided to close the mine temporarily. This would result in flooding the mine and jeopardizing the whole tract adjacent to the property. The Alaska Railroad on representation of these facts by the Geological Survey entered into an arrangement with the operator whereby the railroad would keep the water pumped out and in return would be allowed to mine enough coal to defray the cost. This work was placed in charge of J. J. Corey, who maintained a small force at the mine throughout the year and mined several thousand tons under this arrangement.

TOPOGRAPHIC BRANCH

J. G. STAACK, Chief Topographic Engineer

ORGANIZATION AND PERSONNEL

At the end of the year the organization of the topographic branch was as follows:

Atlantic division, Albert Pike, division engineer, in charge.
Central division, Glenn S. Smith, division engineer, in charge.

Pacific division, H. H. Hodgeson, division engineer, in charge.

Section of inspection and editing, W. M. Beaman, topographic engineer, in charge.

Section of computing, S. S. Gannett, topographic engineer, in charge.

Section of photographic mapping, J. H. Wheat, topographic engineer, in charge.

Section of cartography, A. F. Hassan, cartographic engineer, in charge.

Map information office, J. H. Wheat, topographic engineer, in charge.

Including the above-named engineers, the technical force comprises 174 topographic, geodetic, or cartographic engineers of different grades and 55 engineering aides and draftsmen—a total of 229. The clerical force numbers 17.

The following members of the topographic branch were retired during the fiscal year 1932:

Asahel B. Searle, a native of Washington, D. C., was educated in private schools and in Columbian College (now George Washington University). He was appointed in the Federal service in 1882 and served as an engineer in topographic surveys in many of the States. During the World War he served as captain in the Engineer Corps. He retired March 31, 1932, after 50 years of service.

Samuel S. Gannett, a native of Maine and an alumnus of Bowdoin College and the Massachusetts Institute of Technology, entered the Government service as an engineer in July, 1882. He made geodetic surveys in many States and several times was appointed by the United States Supreme Court as engineer commissioner for service in the settlement of boundary disputes between States, a task in which he was particularly successful. For several years prior to his retirement June 30, 1932, he was in charge of the section of computing.

Basil Duke, a native of Kentucky, was educated in public and private schools and the University of Kentucky. He entered the Government service in July, 1889, and served as an engineer in the General Land Office and in the Geological Survey and as a captain of engineers during the World War. He was retired March 31, 1932, after nearly 43 years of service.

Charles W. Goodlove was educated in the public schools and Northwood Academy in Ohio, his native State. He entered the Government service in July, 1889, and served as a topographic engineer in many of the States until his retirement March 31, 1932, having served approximately 43 years.

William J. Lloyd, a native of Illinois, was educated in the public schools and the Corcoran Scientific School. He was engaged as a mine surveyor for two years prior to his appointment in the Federal service in May, 1894. Except for periods aggregating about 1½ years, when he was engaged in private work, he served as engineer engaged in topographic surveys until his retirement June 30, 1932, having approximately 36½ years of service to his credit.

EXPENDITURES

As shown in the table which follows, the Geological Survey supplements to a notable extent its own appropriations for topographic mapping with State and other Federal funds for similar purposes. Under this policy of cooperation the topographic work is standardized and its cost reduced. The total expenditures for topographic mapping were \$1,167,159.75.

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1933

	Appropriation for topographic surveys	Transfers and repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Topographic surveys, 1932.....	\$780,000.00	\$194,139.05	\$974,139.05	\$382,804.06	\$1,356,943.11
Expenditures:					
Alabama.....	3,864.20		3,864.20	4,022.50	7,886.70
Arizona.....	12,748.49	5,490.14	18,238.63		18,238.63
Arkansas.....	10,684.22		10,684.22		10,684.22
California.....	84,648.31		84,648.31	76,611.67	161,259.98
Colorado.....	12,342.88		12,342.88	8,562.59	17,905.47
Georgia.....		317.61	317.61		317.61
Hawaii.....	974.30		974.30	1,000.00	1,974.30
Idaho.....	16,042.73		16,042.73		16,042.73
Illinois.....	52,988.39		52,988.39	* 39,806.42	92,794.81
Iowa.....	132.33	1,446.35	1,578.68		1,578.68
Louisiana.....	36,447.33	27,898.13	64,345.46		64,345.46
Maine.....	38,159.71	12,956.67	51,116.38	50,002.64	101,119.02
Michigan.....	27,098.30	828.32	27,926.62	26,410.38	54,337.00
Minnesota.....	7,027.19		7,027.19		7,027.19
Mississippi.....		87,821.31	87,821.31		87,821.31
Missouri.....	37,118.69	34,340.13	71,458.82	46,259.72	117,718.54
Montana.....	14,138.21		14,138.21	2,874.82	17,013.03
Nevada.....	13,201.05		13,201.05	7,285.85	20,486.90
New Hampshire.....	25,692.22		25,692.22	9,788.51	35,480.73
New Mexico.....	10,962.76		10,962.76	280.00	11,242.76
New York.....	* 37,923.61		37,923.61	35,611.00	73,534.61
Oregon.....	21,760.51		21,760.51	6,111.30	27,871.81
Pennsylvania.....	32,020.80		32,020.80	37,322.84	69,343.64
Tennessee.....	8,759.80		8,759.80	500.00	9,259.80
Texas.....	2,869.54		2,869.54	2,681.54	5,551.08
Utah.....	16,165.29		16,165.29		16,165.29
Vermont.....	2,636.04		2,636.04	5,000.00	7,636.04
Virginia.....	18,788.33	1,853.22	20,641.55	25,000.00	45,641.55
Washington.....	14,177.00		14,177.00		14,177.00
West Virginia.....	140.44		140.44		140.44
Wisconsin.....	686.58	2,371.30	3,057.88	686.58	3,744.46
Wyoming.....	16,068.19		16,068.19		16,068.19
Books for library.....	321.34		321.34		321.34
Field distribution offices.....	600.00		600.00		600.00
Field instruments, purchase.....	16,964.02		16,964.02		16,964.02
Map information.....	3,582.75		3,582.75		3,582.75
One-millionth maps.....	10,079.45		10,079.45		10,079.45
Computing.....	* 4,055.83	840.00	4,895.83		4,895.83
Inspection and editing.....	* 9,937.45	911.66	9,949.11		9,949.11
Field instruments, repair.....	* 3,803.65		3,803.65		3,803.65
Field stationery.....	* 268.06		268.06		268.06
Office salaries.....	* 9,070.74	2,258.31	11,329.05		11,329.05
Photographic mapping.....	* 2,186.79	655.54	2,742.33		2,742.33
Contingents.....	* 341.12		341.12		341.12
Bureau administration.....	500.00		500.00		500.00
Miscellaneous repay.....		10,157.47	10,157.47		10,157.47
Engraving and printing credit.....	* -45,590.00		-45,590.00		-45,590.00
Refunds and adjustments.....	* -1,072.00	4,092.89	3,020.89		3,020.89
Total expenditures.....	\$ 590,216.64	194,139.05	784,355.69	* 382,804.06	1,167,159.75
Unexpended balance.....	* 189,783.36		189,783.36		189,783.36
Grand total.....	780,000.00	194,139.05	974,139.05	* 382,804.06	1,356,943.11

* Includes \$697.70 Illinois funds expended for surveys in State parks as a repay project.

* Includes delayed charge of \$1,072.00 against 1931 funds not reported as an expenditure in 1931.

* Includes an adjustment of \$1,223.30 between Federal and Monroe County, N. Y., funds for an expenditure erroneously paid and reported as an expenditure from 1931 county funds.

* Represents 35.74 percent of total cost; balance included in charges for projects undertaken in cooperation with the States.

* Total charges for engraving and printing maps resulting from cooperative surveys in 1932 but not expended.

* \$359,798.21 expended on State cooperation exclusive of engraving and printing charges.

* Includes \$45,590.00 unexpended credit for engraving and printing maps resulting from cooperative surveys.

GENERAL OFFICE WORK

Office work incidental to the field work consisted in the inking, inspection, and editing of the completed topographic field sheets prior to their submission for reproduction, the computation and adjustment of the results of control field work, and the preparation of culture and drainage bases from aerial photographs for proposed mapping projects. Office mapping from aerial photographs, by stereophotogrammetric methods, was completed for the Zion National Park, Utah, and nearly completed for the Bryce Canyon National Park, Utah. The Air Corps, United States Army, and outside contractors furnished aerial photographs covering approximately 29,500 square miles for use in the topographic mapping program. In cooperation with the Air Corps, an experimental project was undertaken based upon a new 5-lens camera used at high altitudes, which promises to reduce the amount of control needed. Form sketches made from stereoscopic studies of aerial photographs were experimentally used as a supplement to topographic detail in densely wooded areas. A base map of Georgia was completed, and one of Michigan was nearly completed. Maps were prepared for the Office of Indian Affairs, and map projections were constructed for the Bureau of Chemistry and Soils. Maps were compiled and other illustrations were assembled for publication in the George Washington Atlas. A base map of the Appalachian Valley in Virginia was compiled in preparation for geologic mapping. Charts were prepared for congressional use. (See also p. 85, Inspection and editing of topographic maps.)

SUMMARY OF RESULTS

The status of topographic surveys is set forth by States in the following table, which shows that the country as a whole is now 45.2 per cent mapped, the year's increment amounting to 0.6 per cent, representing the largest area covered in a single year by new surveys and resurveys since 1912. New Hampshire has been added to the list of States completely mapped. The increase in the number of surveys requested by other departments and bureaus was continued. The resurveys in large part covered areas previously surveyed on a smaller scale. The revisions were confined chiefly to the cultural features.

New topographic surveys of the United States, July 1, 1931, to June 30, 1932, and total area surveyed in each State

State	Publication contour interval (feet)	Mapped in fiscal year (square miles) (engraved publication unless otherwise stated) for publication on scale of 1 to —					Total area mapped in fiscal year (square miles)		Total area mapped to June 30, 1932 (square miles)	Percent- age of total State mapped to June 30, 1932 (linear miles)	River sur- vey, scale 1:31,680 (linear miles)	Spirit levels (miles)	Transit traverse (miles)	Triangulation stations occupied
		12,000 or larger	20,000/24,000	31,680	48,000	62,500	125,000/250,000	Revis- ion						
Alabama	20								21,491	41.3		137		
Arizona	5, 20, 25, 100					18	648	18	59,150	51.9	• 199			27
Arkansas	5, 50					182		648	21,974	41.2				
California	5, 25, 50, 100		• 305	821		244	3,170	474	131,047	82.8		1,367	155	27
Colorado	25, 50	• 19	• 13			178		32	56,270	54.1		58		14
Connecticut									4,965	100.0				
Delaware									2,370	100.0				
District of Columbia									70	100.0				
Florida									4,718	8.0				
Georgia									24,937	42.1				
Idaho	5, 20, 50, 100						768	84	82,553	38.8		174		9
Illinois	5, 10, 20		89	• 59	• 28	1,772		33	33,462	62.6		566		
Indiana									3,968	10.1				
Iowa									13,167	23.5				
Kansas									64,159	78.1				
Kentucky									26,620	65.6				
Louisiana	5			• 259		1,098		1,098	9,921	20.5			927	6
Maine	20					1,293		1,293	12,327	57.4		637	165	44
Maryland									8,266	100.0				
Massachusetts	2	(• 1/2, • 1)		• 2,932					14,069	24.3		23	661	
Michigan						27			8,040	9.6			85	
Minnesota	5, 20			2,186				403	6,754	14.4		103		
Mississippi	5, 10, 20			1,973				20	45,990	66.2		1,552	1,395	
Missouri	5, 10, 20						386	26	43,088	29.3		101		17
Montana	100								27,117	35.0				
Nebraska			• 23						584	45.8				
Nevada	25, 100			505	3,290			4	50,680	100.0		299	20	13
New Hampshire	20			456				366	9,302	100.0				
New Jersey									8,224	100.0				
New Mexico	25, 100			325			199	524	42,450	34.6				25
New York	5, 10, 20		305	60				425	49,204	100.0		465	606	
North Carolina									19,040	36.3				
North Dakota									13,148	18.6				
Ohio									41,040	100.0				
Oklahoma							1,490		41,927	93.8				
Oregon	50, 100								36,206	37.4		49	90	31
Pennsylvania	20			1,378				764	37,520	83.0		617	1,285	
Rhode Island									1,248	100.0				
South Carolina									13,737	44.3				
South Dakota									19,243	24.8				

Tennessee.....	5, 20					84		79	5	22, 627	56. 2		189	
Texas.....	50, 100					15			184	88, 284	53. 2			
Utah.....	20					99			99	19, 527	23. 0		399	10
Vermont.....	10, 20					76			88	7, 969	83. 3		46	
Virginia.....	100					600			406	37, 897	88. 9		59	278
Washington.....										36, 813	53. 3			
West Virginia.....										24, 170	100. 0			
Wisconsin.....	20									19, 155	34. 2			
Wyoming.....	5, 25, 100								395	31, 309	32. 0		274	11
Total continental United States (exclu- sive of Alaska).....		19	20	894	4, 338	28	12, 553	7, 967	3, 290	1, 786	5, 461	18, 656	1, 369, 209	45. 2
Hawaii.....													199	7, 684
														5, 676
														233

* Lithographic publication only.

* River survey.

* Includes 84 square miles for lithographic publication only.

* Mapped on scale of 1:12,000.

* Culture and drainage compiled from aerial photographs. Contours not added.

* 0.32 square mile mapped on scale of 1:4,800.

* 0.03 square mile mapped on scale of 1:1,200.

* Includes 137 square miles compiled from aerial photographs by means of stereophotogrammetry.

FIELD SURVEYS

Alabama.—The resurvey of a part of the Adger quadrangle was completed.

Arizona.—At the request of the geologic branch the survey of the Ajo quadrangle was completed. The survey of the Camp Verde quadrangle for the Forest Service was continued. The survey of the Salt River, including parts of the White and Black Rivers and Carrizo Creek, was completed for the conservation branch.

Arkansas.—For the Forest Service the survey of the Treat quadrangle was completed. In cooperation with the United States Army district engineer at Memphis, Tenn., the survey of the Horn Lake quadrangle was completed.

California.—In cooperation with the State engineer of California, the survey of the Dunsmluir, Etna, Hinkley, La Panza, White River No. 2, Harvester, West Camp, Lone Tree Well, No. 57, Lost Hills special, Antelope Plain, Cloud, Santa Ana No. 1, Santa Ana No. 2, Santa Ana No. 3, Anaheim No. 2, Anaheim No. 3, Downey No. 4, and Las Bolsas No. 1 quadrangles was completed and that of the Anaheim No. 1, Anaheim No. 4, Corona 4-c, Corona 4-b, Treadwell, No. 65, Colfax, and Truckee quadrangles was begun. In cooperation with the county surveyor of Los Angeles County, the survey of the Castaic, Red Rover, Redrock Mountain, Warm Spring Canyon, Red Mountain, Whitaker Peak, Oak Flat, La Brun, and Santa Felicia Canyon quadrangles was completed, that of the Beartrap Canyon quadrangle was continued, and that of the Fairmont, Lake, Palmdale, Hughes Lake, and Mint Canyon quadrangles was begun. A partial revision of the Chatsworth quadrangle was completed. In preparation for geologic mapping the survey of the White River No. 3 quadrangle and the Kramer borate district was completed. At the request of the Forest Service the survey of the Hoaglin quadrangle was continued and that of the Yreka quadrangle was begun. A small area in Yosemite National Park was revised for the National Park Service.

Colorado.—In cooperation with the Colorado Metal Mining Fund and the Colorado Geological Survey Board, the survey of Silverton and vicinity and Jamestown and vicinity was completed. For the Forest Service the survey of the Mount Powell No. 2 quadrangle was begun.

Idaho.—The Bureau of Mines and Geology of Idaho cooperating, the survey of the Gilmore mining district was completed. The survey of the Buffalo Hump quadrangle was completed and that of the Trout Creek quadrangle was begun at the request of the Forest Service. In preparation for geologic mapping, the survey of the Irwin quadrangle was continued. At the request of the National Park Service, the survey of an extension of Yellowstone National Park was begun.

Idaho-Wyoming.—The survey of the Snake River from Pine Creek, Idaho, to Horse Creek, Wyo., with miscellaneous dam sites, was completed for the conservation branch.

Illinois.—The survey of the Geneseo, French Village, and Waterloo No. 1 quadrangles was completed, that of the Virginia, Keithburg, Carthage, Galva, Prophetstown, Orion, Potomac, Jacksonville, and Walnut quadrangles was continued, and that of the Pecatonica, Harvard, Marshall, Lomax, Hoyleton, Oquawka, Hoopeston, Shiloh, and Collinsville quadrangles was begun, and a partial revision of the Winchester quadrangle was completed. This work was done in cooperation with the Department of Registration and Education of Illinois, Geological Survey.

Louisiana.—In cooperation with the United States Army district engineer at New Orleans, the survey of the Covington, Slidell, Ponchatoula, Springfield, and Denham Springs quadrangles was completed. The board of State engineers cooperating, the compilation from aerial photographs of culture and drainage was completed for the Barataria quadrangle, and that of the New Orleans, Cut-Off, Houma, Hahnville, Thibodaux, Lac des Allemands, Gibson, and Schooner Bayou quadrangles was begun.

Maine.—In cooperation with the Public Utilities Commission of Maine, the survey of the Ashland, Saponac, Fish River Lake, Springfield, Stetson, Boyd Lake, and Mooseleuk Mountain quadrangles was completed, that of the Nicasotus Lake quadrangle was continued, and that of the Keeobscus Stream and Wabassus Lake quadrangles was begun. In cooperation with the War Department the survey of the Van Buren and Johns Pond quadrangles was completed.

Michigan.—In cooperation with the Department of Conservation of Michigan, Geological Survey, the compilation from aerial photographs of the culture and

drainage was completed for Schoolcraft County, including the Driggs Lake, Manistique, and Manistique River quadrangles and the county parts of the Seney, Blaney, Seul Choix Point, Cooks, Steuben, Uno, Shingleton, Grand Portal, Point Au Sable, Munising, and Grand Marais quadrangles; and was begun for Mackinac County, completing the Gould City, Point Patterson, and Gilchrist quadrangles, the county parts of the Blaney, Epoufette, Seul Choix Point, and Moran quadrangles, and parts of the St. Ignace, Ozark, Budyard, Pickford, Raber, Bois Blanc, and Beavertail Point quadrangles; for Oceana County, completing the Hart and Little Sable Point quadrangles and the county parts of the Ludington, Fern, and Walkerville quadrangles and parts of the Montague and Twin Lake quadrangles; for Mason County, completing the Big Sable Point quadrangle, the county parts of the Ludington and Fern quadrangles, and parts of the Manistee and Freesoil quadrangles; for Lake County, completing the county part of the Fern quadrangle and parts of the Peacock, Baldwin, Luther, Nirvana, and Freesoil quadrangles; and for Delta County, including the Burnt Bluff, Sturgeon River, Rapid River, Peninsula Point, Brampton, Escanaba, Whitney, and Bark River quadrangles. In cooperation with the Department of Justice the survey of a prison site and grounds near Milan was completed.

Minnesota.—The survey of the Ely quadrangle was begun at the request of the Forest Service.

Mississippi.—In cooperation with the United States Army district engineer at Memphis, Tenn., the survey of the Horn Lake, Crenshaw, Marks, Sledge, Crowder, Clarksdale, and Tutwiler quadrangles was completed, and in cooperation with the United States Army district engineer at Vicksburg the survey of the Greenwood, Schlater, Sumner, Mound Bayou, Cleveland, and Philipp quadrangles was completed.

Missouri.—In cooperation with the United States Army district engineer at Memphis, Tenn., the survey of the Puxico, Zalma, Poplar Bluff, Morley, and Advance quadrangles was completed. The survey of the Pacific quadrangle was continued, and that of the Manchester, Elsey, Bandyville, Clear Springs, Leeper, Upalika, Franks, Drynob, Sleeper, Manes, Plum Valley, Celt, Greenville, Buffalo, Protom, Versailles No. 3, Long Lane, Couch, Summersville, Cedar Grove, Salem, Fordland, Thornfield, Steelville, Topas, Zanol, Big Piney, Grove Springs, Edgar Springs, Gatewood, and Niangua quadrangles was begun in cooperation with the State geologist of Missouri.

Montana.—The survey of the Trout Creek quadrangle was continued at the request of the Forest Service. For the National Park Service the survey of an extension of Yellowstone National Park was begun.

Nevada.—The survey of the Lovelock quadrangle and the Eureka mining district was completed and that of the Sonoma Range quadrangle was begun in cooperation with the Bureau of Mines of Nevada. The survey of the Halleck quadrangle was completed for the Forest Service.

New Hampshire.—In cooperation with the Highway Department of New Hampshire the survey of the Woodsville, Groton, Lowell, Fitchburg, Haverhill, Lawrence, and Guildhall quadrangles was completed, and that of the Newburyport, Monadnock, and Keene quadrangles was begun.

New Mexico.—For the Forest Service the survey of the Talpa quadrangle was continued and that of the Ute Creek and Questa quadrangles was begun. In preparation for geologic mapping, the survey of the Lordsburg special quadrangle was completed and that of the Lordsburg No. 3 and Lordsburg No. 4 quadrangles was begun.

New York.—The survey of the Ramapo and Rochester East quadrangles was completed and that of the Tarrytown No. 4 quadrangle was begun in cooperation with the Department of Public Works of New York. In cooperation with Monroe County and the Department of Public Works of New York the survey of the Rochester West, Genesee Junction, Mendon Ponds, Ninemile Point, and Rush quadrangles was completed and that of the Brockport Nos. 1, 2, 3, and 4 and Macedon Nos. 2 and 3 quadrangles was begun.

Oregon.—The survey of the Pendleton quadrangle was completed and that of the Medford quadrangle was begun in cooperation with the State engineer of Oregon. In preparation for geologic mapping the survey of the Dayville quadrangle was completed. For the Forest Service, the survey of the Lava Butte quadrangle was completed.

Pennsylvania.—In cooperation with the Department of Internal Affairs of Pennsylvania, Topographic and Geologic Survey, the survey of the Millville,

Laporte, and Trowbridge quadrangles was completed, that of the Susquehanna and Smethport quadrangles was begun, and the cultural revision of the Fayette County part of the Connellsville, Uniontown, Donegal, Confluence, Brownsville, Morgantown, Masontown, Accident, and Bruceton quadrangles was completed.

Tennessee.—The survey of the Sassafras Mountain quadrangle was begun at the request of the Forest Service. In cooperation with the United States Army district engineer at Memphis, the survey of the Horn Lake quadrangle was completed.

Utah.—The survey of Zion National Park was completed and that of Bryce Canyon National Park was begun for the National Park Service. At the request of the geologic branch the survey of the Richfield No. 3 quadrangle was begun.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Mount Cube quadrangle was completed and that of the Littleton quadrangle was begun.

Virginia.—The survey of the Healing Springs, Accomac, and Elkton quadrangles was completed, that of the Timber Ridge, Marion, Mount Rogers, Rural Retreat, Mouth of Wilson, Pearisburg, and Blacksburg quadrangles was continued, and that of the Peterstown and Richmond No. 2 quadrangles was begun, all in cooperation with the Conservation and Development Commission of Virginia, Geological Survey. In cooperation with the War Department and the Fredericksburg and Spotsylvania County Battlefields Memorial Commission, the survey of the Salem Church battlefield and the Chancellorsville battlefield was completed.

Washington.—For the Forest Service the survey of the Mount Constance quadrangle was continued. In preparation for geologic mapping the survey of the Metaline quadrangle was begun.

Wisconsin.—In cooperation with the War Department the survey of Camp Williams was completed.

Wyoming.—The survey of the Jackson quadrangle was completed and that of the Savery Creek quadrangle was begun at the request of the Forest Service. At the request of the geologic branch the survey of the Irwin quadrangle was completed.

WATER-RESOURCES BRANCH

N. C. GROVER, Chief Hydraulic Engineer

ORGANIZATION AND PERSONNEL

The water-resources branch, like other branches of the Geological Survey, is primarily an agency of research and investigation. It collects systematically for general public information and use facts in regard to the quantity, quality, and utilization of water. The widespread interest in the availability of water for many uses has led to a persistent and increasing demand for reliable data that would serve as a basis for safe and sane developments. During the year the work of the branch has been administered under the following units:

Division of surface waters, C. G. Paulsen, hydraulic engineer, in charge.

Division of ground water, O. E. Meinzer, geologist, in charge.

Division of quality of water, W. D. Collins, chemist, in charge.

Division of power resources, A. H. Horton, hydraulic engineer, in charge.

Division of water utilization, R. W. Davenport, hydraulic engineer, in charge.

The technical force at the end of the year comprised the chief hydraulic engineer, 31 senior hydraulic engineers, 20 hydraulic engineers, 157 associate, assistant, and junior engineers, 2 engineering field aides, 4 senior geologists, 2 geologists, 10 assistant and junior geologists, 1 senior chemist, 1 chemist, 5 assistant and junior chemists, 3 laboratory assistants and apprentices, 1 illustrator, and 1 computer—a total of 239. The clerical force numbered 46. The changes in personnel during the year show a net increase of seven.

FUNDS

The funds available for Geological Survey work on water resources were as follows:

Gaging streams-----	\$711, 000. 00
Transfers from Federal agencies-----	200, 723. 00
Repayments by Federal agencies-----	6, 822. 60
Cooperative funds furnished by States and municipalities-----	548, 337. 64
Noncooperative funds furnished by State and municipalities-----	4, 996. 53
Funds furnished by permittees and licensees of the Federal Power Commission-----	33, 354. 93
	<hr/> 1, 505, 234. 70

COOPERATION

Work in the branch is largely conducted in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional services in field and office.

Alabama-----	\$2, 230. 97	Nevada-----	\$1, 050. 00
Arizona-----	20, 609. 65	New Hampshire-----	2, 714. 90
Arkansas-----	1, 422. 00	New Jersey-----	19, 871. 93
California:		New Mexico-----	17, 293. 57
State-----	\$52, 982. 00	New York:	
Municipal-----	19, 587. 72	State-----	\$21, 813. 86
	<hr/> 72, 569. 72	Municipal-----	1, 713. 51
Connecticut:			<hr/> 23, 527. 37
State-----	6, 407. 48	North Carolina-----	11, 802. 25
Municipal-----	850. 00	North Dakota-----	2, 305. 88
	<hr/> 7, 257. 48	Ohio:	
Florida		State-----	14, 685. 95
State-----	4, 499. 30	Municipal-----	2, 930. 79
Municipal-----	2, 495. 47		<hr/> 17, 616. 74
	<hr/> 6, 994. 47	Oregon:	
Hawaii-----	31, 394. 75	State-----	41, 375. 39
Idaho-----	17, 426. 42	Municipal-----	545. 93
Illinois-----	7, 520. 48		<hr/> 41, 921. 32
Indiana:		Pennsylvania-----	23, 257. 28
State-----	4, 067. 25	South Carolina:	
Municipal-----	624. 30	State-----	5, 000. 00
	<hr/> 4, 691. 55	Municipal-----	340. 15
Kansas-----	6, 096. 18		<hr/> 5, 340. 15
Kentucky-----	354. 27	Tennessee-----	13, 511. 15
Maine-----	6, 997. 68	Texas-----	42, 964. 94
Maryland:		Utah:	
State-----	4, 259. 89	State-----	5, 713. 74
Municipal-----	1, 741. 62	Municipal-----	5, 131. 53
	<hr/> 6, 001. 51		<hr/> 10, 845. 27
Massachusetts-----	6, 761. 67	Vermont-----	4, 863. 78
Michigan-----	95. 83	Virginia-----	23, 800. 14
Minnesota:		Washington:	
State-----	1, 283. 24	State-----	6, 085. 07
Municipal-----	1, 154. 42	Municipal-----	10, 768. 25
	<hr/> 2, 437. 66		<hr/> 16, 853. 32
Mississippi-----	1, 712. 79	West Virginia-----	3, 500. 00
Missouri-----	11, 243. 79	Wisconsin-----	6, 985. 28
Montana-----	8, 657. 41	Wyoming-----	10, 964. 50
Nebraska-----	21, 871. 29		<hr/> 548, 337. 64

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects was continued on the Black Canyon project and on the lower Colorado River. A reconnaissance was made for a gaging station site near Hoover Dam.

Indian Service.—Stream gaging was continued on the Gila and San Carlos Rivers and was also done in the Blackfoot River Basin of the Fort Hall project and on the Western Shoshone and Yakima Indian reservations.

National Park Service.—Streams in the Yellowstone National Park were measured during the year at stations maintained in cooperation with the National Park Service, and an investigation was made of the ground-water supply at Yorktown, Va.

Department of the Navy.—An investigation for the development of a ground-water supply at the Puget Sound Navy Yard, Washington, was made for the Bureau of Yards and Docks.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued.

Weather Bureau.—Stream gaging was continued on the Colorado River in Arizona, and a study was made of the flow of the Columbia River at Umatilla, Oregon.

Office of Public Buildings and Public Parks of the National Capital.—A study of the flow of Rock Creek was continued.

Department of State.—Investigations were continued in connection with matters which fall within the scope of the jurisdiction of the International Joint Commission, the cost thereof being borne by funds transferred to the Geological Survey by the State Department. This work includes stream gaging and surface and ground water studies at points along the boundary between the United States and Canada where international problems are involved. Approximately 100 gaging stations were operated in connection with these investigations; 48 of them were international stations operated jointly or in collaboration with the Dominion Water Power and Hydrometric Bureau because of their relation to matters involving the jurisdiction of the International Joint Commission and the common interest of the two countries. Stream gaging on the Rio Grande on the Mexican boundary was discontinued by the Geological Survey and turned over to the International Water Commission, United States and Mexico, at the beginning of the fiscal year.

Veterans' Administration.—An investigation for the development of a ground-water supply near San Fernando and at Sawtelle, Calif., was made for the Construction Service.

Department of Justice.—An investigation was made of the ground-water supply for the proposed Federal prison near Milan, Mich.

Corps of Engineers, United States Army.—Stream gaging in connection with studies and reports under House Document 308 of the Sixty-ninth Congress, first session, which has been conducted in connection with the Corps of Engineers for three years or more, was essentially completed September 30, 1931. Stream gaging in cooperation with the corps has been continued in connection with authorized projects related to navigation and flood control at about 122 stations in the Pittsburgh, Huntington, Jacksonville, Mobile, Nashville, Kansas City, and St. Paul Army Engineer districts.

Federal Power Commission.—The stream gaging required in connection with permits and licenses issued for the development of water power under the Federal water-power act has been performed or supervised by engineers of the Geological Survey in Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Iowa, Indiana, Kentucky, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, New Mexico, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Tennessee, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming. Operations of projects under permits and licenses have been supervised in Arizona, Arkansas, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wisconsin, and Wyoming.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 45 reports and 5 separate chapters. (See pp. 2-3.) At the end of the year 20 other reports were in press.

CHARACTER AND METHODS OF WORK

The study of surface waters, which consists of the measurement of the flow of rivers, has been conducted in 48 States, the District of Columbia, and Hawaii at selected gaging stations where the volume of water is measured and records of stage and other data are collected, from which the daily discharge of the rivers is computed. In this work 39 States and several Government organizations and individuals cooperated in the maintenance of the regular gaging stations. At the end of the year 2,791 gaging stations were being maintained. Records for about 135 additional stations were received, ready for publication, from Government bureaus and private persons.

The division of ground water investigates the waters that lie below the surface in the zone of saturation (from which the wells and springs are supplied); the source, occurrence, quantity, and head of these waters; their conservation; their availability and adequacy for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers; and the methods of constructing wells and recovering water from them and of improving springs. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to the chemical composition of the water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects. During the fiscal year about 50 investigations relating to ground-water and reservoir sites were in progress, and work was done in 25 States, 15 of which cooperated, and in Hawaii.

Cooperation was continued with the 11 State associations of water-well drillers and with the American Association of Water Well Drillers. A. G. Fiedler attended the annual meeting of that association at Milwaukee, Wis., and presented a paper entitled "Mud-scow drilling." He also conferred with a joint committee of the American Association and the American Specification Institute regarding standard specifications for the drilling of wells.

Abstracts of papers relating to ground-water hydrology were prepared for the "Annotated bibliography of economic geology" under the direction of A. N. Sayre. In the hydrologic laboratory V. C. Fishel analyzed 283 samples of water-bearing material.

A course of daily lectures and discussions on the principles of ground-water hydrology and the methods of ground-water work was conducted from February 1 to March 18. O. E. Meinzer read as his presidential address before the Geological Society of Washington a paper on the subject "History and development of ground-water hydrology" and also presented a paper entitled "Relation of ground water to stream flow" at the meeting of the hydrologic power committee of the National Electric Light Association at Cincinnati, Ohio.

The following papers were presented before the meeting of the section of hydrology of the American Geophysical Union and were published in the Transactions of the Union:

Recent investigations of Thiem's method for determining permeability of water-bearing materials, by L. K. Wenzel.

Equation of lines of flow in vicinity of discharging well, by C. V. Theis.

Investigations of the fluctuations of water levels in observation wells in Virginia, by R. C. Cady.

Investigations of the fluctuations of the ground-water table in Pennsylvania, by S. W. Lohman.

Report of the committee on underground water, by D. G. Thompson.

The work on the quality of water included the analysis of the mineral content of 1,025 samples of water from surface and underground sources with reference to the suitability of the waters for industrial and agricultural uses and for domestic use (not related to questions of health), so far as such use is affected by the dissolved mineral matter. The analyses included some for nearly all the studies of ground water in the different States as noted below. Close cooperation was continued with the division of ground water in the study of problems relating to quality of ground water and the preparation of the parts of ground-water reports that involve consideration of the chemical character of the waters. Work was well advanced on the collection of data and the making of analyses for the revision of Water-Supply Paper 496. The studies of the Colorado River and its tributaries were extended to gain further information as to the contribution of the upper tributaries to the load of dissolved and suspended matter carried by the river. Progress was made on the study of some special methods of analysis. A number of partial analyses were made of samples of rain and snow.

The work of the division of power resources comprised the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants, a report on the developed water power of the United States, a report containing the monthly and annual figures of output by States for 1931, and compilations of the stocks of coal held by electric public-utility power plants for inclusion in reports of commercial stocks of coal undertaken quarterly by the Bureau of Mines of the Department of Commerce.

The annual report on the capacity of water wheels in water-power plants in the United States was released February 5, 1932, and the final report on the monthly and annual production of electricity for public use in 1931 was released April 29, 1932.

The division of water utilization investigates problems affecting the utilization of the waters of streams and performs administrative work relating to supervision and investigation by the field organization of the water-resources branch and of power projects of the Federal Power Commission and of the Interior Department. The field work is generally conducted by personnel otherwise assigned to the division of surface water.

Studies of flood control pertaining to the Roseau River reference before the International Joint Commission were continued in northern Minnesota. The flow of the St. Mary and Milk Rivers, international streams in northern Montana, was divided in accordance with treaty agreement. Studies and reports were made for the International Joint Commission in connection with its consideration of the apportionment of the waters of these streams. The application of a Canadian power company for approval by the International Joint Commission of a dam on the Kootenai River in Canada which is capable of causing backwater in Idaho has necessitated extensive studies of the effect of the dam on the behavior of surface and ground water on the United States side of the boundary. Numerous investigations have been made of a wide variety of problems of water utilization.

At the request of the Federal Power Commission, 30 engineers of the water-resources branch have been designated as representatives of the commission to perform for the commission such field work as may be assigned to them. The operation of about 320 gaging stations was conducted by the branch or was performed by permittees and licensees under the supervision of the branch in connection with 130 projects of the Federal Power Commission. Engineers of the branch have had general supervision of operations under permits and licenses of the Federal Power Commission in connection with 100 projects. Examinations and reports on applications for projects have been made for the commission as requested. Similar activities have been required for certain power projects operating under authority of the Secretary of the Interior. The administrative detail pertaining to such general supervision of projects and examinations and reports was performed in the conservation branch, and the pertinent field work was carried on under a coordinate arrangement through the district offices of the water-resources branch.

WORK OF THE YEAR BY STATES

The following table shows by States the number of gaging stations maintained for the collection of stream-flow records and the interest in those stations of the agencies cooperating with the Geological Survey:

Gaging stations and cooperating parties for the year ending June 30, 1932

State or Territory	Federal non-cooperative				Cooperative		Permits and licenses of the Federal Power Commission	Miscellaneous and partial support			Counted more than once	Maintained at end of year	Established during year	Discontinued during year	Gagings		
	Geological Survey	War Department	State Department	Other Federal bureaus	State	Municipal		Federal bureau	State or municipal	Individual or corporate					Regular	Miscellaneous	
Alabama.....	10	1			^a 2		5	2			2	18	2	17		314	2
Arizona.....	9			4	37						4	46	4	20		2,404	6
Arkansas.....	1				7		4		2	1	3	12	3	8		58	5
California.....					^b 213	15	64	20	27	16	63	292	22	11		7,315	688
Colorado.....	1				^c 2		9					13	5	22		166	
Connecticut.....					^d 23	1			1		2	24	5	1		183	
Delaware.....					^e 4							4	4			73	19
Florida.....	6	4			30		6				4	42	18	2		334	73
Georgia.....	7	1			^f 2		7				2	17	6	15		156	9
Idaho.....	4		32	1	237		18	13	18	110	142	291	124	113		1,925	262
Illinois.....	1				37		1	3	2	1	6	39	5	1		244	2
Indiana.....	1				30			5	3	4	12	31		2		180	
Iowa.....	2	1					1					4	2	4		67	1
Kansas.....					44			4		1	5	44	31	34		474	4
Kentucky.....	4						4	5			5	8		28		122	1
Louisiana.....														1		2	
Maine.....					33					11	11	33	4			255	1
Maryland and District of Columbia.....	2			2	15	8						27	8	3		281	30
Massachusetts.....					26					1	1	26	2			176	
Michigan.....							3				1	2				5	1
Minnesota.....	3	3	22		19		3					50	15	22		385	22
Mississippi.....	4									1	1	4		7		191	1
Missouri.....	4	3			81		4		8	8	16	92	11	10		739	8
Montana.....	6	13	36		^g 54		12	1				122	18	15		784	8
Nebraska.....	2	1			46					1	1	49	62	27		968	881
Nevada.....					12			3	1	4	8	12	1			27	
New Hampshire.....					^h 20				8	8		20		3		125	
New Jersey.....					46			1	8	7	16	46	1			355	44
New Mexico.....					63			3	2	7	12	63	77	15		873	125
New York.....					ⁱ 98	1		1	1	37	39	99	1	5		781	12
North Carolina.....	7				60		4			1	1	71	2	7		423	14
North Dakota.....	3	2	5		13							23	7	4		196	2
Ohio.....					91	14		6	1	4	11	105	2	3		707	11
Oklahoma.....	1						1		1			3		6		20	
Oregon.....	5				162	5	20	7	1	24	33	191	105	7		1,489	49
Pennsylvania.....					^j 90		7	7	2	6	17	95	6	13		364	46
Rhode Island.....					^k 1							1				7	
South Carolina.....	5				12	3	6				7	19	3	1		155	7
South Dakota.....	8				^l 2		1					11	13	22		221	
Tennessee.....	10	2			96		4	1	37	5	43	112	41	6		767	134
Texas.....	2				98		7	7	5	19	100	9	20			1,364	186
Utah.....	4				^m 54		3	5	3	15	26	58	2	1		597	43
Vermont.....					26					3	3	26	1	1		173	
Virginia.....		1			85			1	14	16		85	9	7		483	24
Washington.....	9		11	2	50	17	15	2	1	24	28	103	11	24		775	42
West Virginia.....	7				30		10	10	1	2	13	47	1	13		284	23
Wisconsin.....	3	2			36		3	1		5	6	44	1	4		293	7
Wyoming.....	1				ⁿ 65			16		2	7	77	32	24		517	40
Hawaii.....					90			1	13	27	41	90	8	6		558	28
	132	34	106	9	2,242	64	215	124	141	359	635	2,791	683	555		29,344	2,884

• Cooperation by Tennessee on 2 stations.

• Cooperation by Nevada on 2 stations.

• Cooperation by Nebraska on 1 station and by Wyoming on 1 station.

• Cooperation by Massachusetts on 1 station.

• Cooperation by Pennsylvania.

• Cooperation by Tennessee.

• Cooperation by Wyoming on 1 station.

• Cooperation by Maine on 2 stations and by Vermont on 1 station.

• Cooperation by Pennsylvania on 2 stations.

• Cooperation by Maryland on 2 stations.

• Cooperation by Massachusetts.

• Cooperation by Minnesota on 1 station and by Wyoming on 1 station.

• Cooperation by Wyoming on 1 station.

• Cooperation by Nebraska on 1 station and by Idaho on 2 stations.

Arkansas.—The investigation in the Grand Prairie region was continued in cooperation with the State Geological Survey. Records were obtained by A. H. Prince, under the direction of D. G. Thompson, of water levels in numerous observation wells, and these records were released to the public in manuscript form.

California.—Water levels were measured in selected wells in southern California under the direction of F. C. Ebert. The record now covers a period of 28 years. Work was continued with the financial support of the East Bay Municipal Utility District on the investigation of the ground water in the alluvial fan of the Mokelumne River, and the results were released in manuscript form. This investigation was placed in charge of A. M. Piper, who was assisted by H. S. Gale, C. A. McClelland, G. M. Sherwood, B. R. Colby, and H. E. Thomas. A. G. Fiedler spent two weeks in studying well-drilling methods in California and attended a meeting of water-well drillers in Oakland. Investigations and reports were made by S. W. Lohman relating to ground-water supplies for the Veterans' Administration home in Los Angeles and the Veterans' Administration hospital near San Fernando. Analyses were made of samples collected regularly from the Sacramento River at Sacramento.

Colorado.—A. G. Fiedler attended a meeting of water-well drillers in Denver.

Florida.—The investigation of the ground-water resources of Florida was continued, in cooperation with the State Geological Survey, by V. T. Stringfield, under the direction of D. G. Thompson. Mr. Stringfield did field work in Duval, St. Johns, Seminole, Orange, Pinellas, Hillsborough, Manatee, Sarasota, and Charlotte Counties and nearly completed a report on Sarasota County.

Hawaii.—The investigation on the island of Oahu, in cooperation with the Territorial Commission of Public Lands, was continued by H. T. Stearns and K. N. Vaksvik, who nearly completed a comprehensive report on the ground-water resources of that island. A report on the Pearl Harbor Springs, by H. T. Stearns, was released in manuscript form.

Idaho.—Parts of the comprehensive report on ground water in the Snake River Plains, by H. T. Stearns, Lynn Crandall, and W. G. Steward, were released in manuscript form, including a section entitled "Loss and gain of water in the Snake River between Helse and King Hill, Idaho," and the records of wells in the area. The section entitled "Inventory of the water supply on the Snake River Plains in southeastern Idaho" was released in mimeographed form. An investigation of the surface and ground waters of Malad and Curlew Valleys was made in cooperation with the Idaho Department of Reclamation. A report by D. G. Thompson on the ground-water conditions and by R. W. Faris on the reservoir sites was released in manuscript form.

Kansas.—A. G. Fiedler attended a conference of water-well drillers at El Dorado.

Michigan.—R. M. Leggette made an investigation and report for the United States Bureau of Prisons in regard to a proposed water supply at Milan. Plans were made for cooperation with the State geologist for comprehensive investigations of ground-water conditions in the State with special reference to fire protection. D. G. Thompson spent a week in preliminary field work and conference in regard to this project. The district office at Lansing, in charge of Berkeley Johnson, was closed June 30.

Minnesota.—A. G. Fiedler made two trips to Minneapolis to confer with well drillers.

Missouri.—A. G. Fiedler presented a paper on sanitary well construction at the seventh annual Missouri Water and Sewer Conference, in Jefferson City. He also attended the Missouri Well Drillers' convention in Jefferson City.

Montana.—The report by G. M. Hall on ground water in Big Horn County was completed, and progress was made by him on the report on Fergus County.

Nebraska.—The investigation of the ground-water resources of the Platte River Valley was continued in cooperation with the State Conservation and Survey Division, by A. L. Lugin and L. K. Wenzel.

New Jersey.—Comprehensive investigation of the ground-water resources of New Jersey was resumed, through cooperation with the State Water Policy Commission, by D. G. Thompson, H. C. Barksdale, and R. W. Sundstrom. Special attention was given to the conditions in the Runyon, Atlantic City, and Camden areas. A paper entitled "Ground-water supplies of the Atlantic City region" was presented by Mr. Thompson at the meeting of the Four States section of the American Water Works Association in Atlantic City and is to be published in the journal of that association.

New Mexico.—Cooperation was continued with the State engineer in the Roswell artesian basin by A. G. Fiedler, in Mimbres Valley by W. N. White, in Lea County by S. S. Nye, and in Roosevelt and Curry Counties by C. V. Theis. A comprehensive report on the Roswell artesian basin by Messrs. Fiedler and Nye was released in manuscript form. A district office was established at Santa Fe July 16, 1931, with Berkeley Johnson, engineer, in charge.

New York.—An investigation of the ground-water resources of the State was undertaken in cooperation with the joint legislative committee concerned with water resources. Work was begun on Long Island by D. G. Thompson, A. G. Fiedler, and Kyle Forrest. A brief preliminary report was published in New York Legislative Document 104, and some of the data obtained were released in manuscript form.

North Carolina.—O. E. Meinzer spent a week in field work and conference with the State Division of Water Resources and Engineering in regard to observations of water levels in wells and their relation to stream flow.

Ohio.—O. E. Meinzer attended a conference with the State Water Conservation Board of Ohio in regard to plans for a comprehensive survey of the ground-water resources of the State.

Oklahoma.—A. G. Fiedler prepared a paper entitled "Improper construction as a cause of well pollution," which was read at the eighth Oklahoma Sewage and Water Conference at Stillwater and is to be published in the Southwest Waterworks Journal.

Oregon.—Investigations of the ground-water resources of Oregon were continued in cooperation with the State Agricultural Experiment Station. A preliminary report on the Harney Basin was issued in mimeographed form, and field work in that basin was continued by A. M. Piper, T. W. Robinson, and C. F. Park, jr. A. G. Fiedler conferred with drillers in the State in regard to well-drilling methods.

Pennsylvania.—The systematic survey of the ground-water resources of Pennsylvania was continued in cooperation with the State Topographic and Geologic Survey. The report by G. M. Hall on the southeastern part of the State was released in manuscript form, and the report on the northwestern part of the State by R. M. Leggette and that on the northeastern part by S. W. Lohman were virtually completed. A preliminary report on the northeastern area was released in mimeographed form. About 35 observation wells were selected on which weekly measurements of water level are made. The results have been released in mimeographed or manuscript form.

Tennessee.—The report on ground water in south-central Tennessee was nearly completed by C. V. Theis, and observations were continued on water levels in wells in Memphis. The reports on north-central Tennessee by A. M. Piper and on western Tennessee by F. G. Wells are now in press as water-supply papers. All the ground-water work was done in cooperation with the State geologist.

Texas.—Investigations of the ground-water resources of Texas were continued in cooperation with the State Board of Water Engineers, under the direction of W. N. White. The Texas Department of Health and the Bureau of Engineering Research of the Agricultural and Mechanical College also continued to cooperate. Studies of the geology and ground-water resources in the Toyah Basin, in Reeves, Ward, and Pecos Counties, were continued by H. S. Gale and S. S. Nye. The ground-water investigation in Harris County, including the Houston area, was expanded to include parts of Montgomery, Waller, Fort Bend, Brazoria, and Galveston Counties. This investigation was conducted by P. P. Livingston, S. F. Turner, C. W. Cooke, and T. W. Bridges. A survey of the ground-water resources of Bexar County was begun by S. F. Turner. Observations of water-level fluctuations in wells and studies of salt-water contamination were continued in the Winter Garden district by W. A. Lynch. J. T. Lonsdale continued the investigation of the ground-water resources of Webb County and started work in La Salle County. An investigation and report concerning ground-water conditions in the East Texas oil field, in Upshur, Gregg, Rusk, and Smith Counties, were made by S. F. Turner and P. P. Livingston. Further work was done by A. N. Sayre in Medina and Uvalde Counties, by T. W. Robinson and S. F. Turner in Dimmit and Zavala Counties, and by J. T. Lonsdale in Atascosa and Frio Counties. A. G. Fiedler conferred with officials of the United States Department of Justice regarding the completion of a well to provide a water supply for the United States detention farm at El Paso. A paper on the results of the cooperative State and Federal investi-

gation of the ground waters of Texas, prepared by W. N. White, was presented at the fourteenth Texas Water Works Short School at Mineral Wells.

Utah.—An investigation of the ground-water resources of the Jordan Valley, with special reference to an increased water supply for Salt Lake City, was begun in cooperation with the city, by R. M. Leggette and G. H. Taylor.

Virginia.—Cooperation was begun with the State Geological Survey in a comprehensive survey of the ground-water resources of the State. Field work was completed by R. C. Cady in Arlington, Fairfax, Prince William, Loudoun, Clarke, and Frederick Counties. Water-stage recorders were operated on the observation well in Arlington County and on the ebbing and flowing spring near Broadway. A recorder was installed on an ebbing and flowing spring near Marion. A memorandum for the press was issued on the fluctuations of the Arlington well and their relation to precipitation. Special investigations were made by R. C. Cady at Virginia Beach and at several localities in the Shenandoah Valley. An investigation relating to a water supply at Yorktown was made by A. G. Fiedler for the National Park Service.

Washington.—An investigation and report were made by J. T. Pardee for the Navy Department in regard to ground-water supplies at the United States navy yard at Bremerton. A. G. Fiedler conferred with drillers in the State in regard to well-drilling methods.

Wisconsin.—A. G. Fiedler attended the annual meeting of the Wisconsin Well Drillers Association at Milwaukee.

CONSERVATION BRANCH

HERMAN STABLER, *Chief*

ORGANIZATION AND PERSONNEL

The work of the conservation branch, comprising the classification of public lands with respect to mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands, was directed at the end of the year through five administrative divisions, as follows:

Mineral-classification division, J. D. Northrop, geologist, in charge.

Power division, B. E. Jones, hydraulic engineer, in charge.

Agricultural division, J. F. Deeds, hydraulic engineer, in charge.

Mining division, H. I. Smith, mining engineer, in charge.

Oil and gas leasing division, H. B. Soyster, petroleum engineer, in charge.

The mineral-leasing division of former years was subdivided about the middle of the fiscal year to facilitate administration of its major elements—mining operations and oil and gas operations.

On June 30, 1932, the permanent full-time personnel of the branch numbered 153, consisting of 5 geologists, 9 hydraulic engineers, 12 mining engineers, 40 petroleum engineers, 1 classification engineer, 7 agricultural classifiers, 1 chemist, 1 attorney, 22 accountants and draftsmen, and 55 clerical and miscellaneous employees.

FUNDS

The funds appropriated or transferred for the work of the conservation branch in the fiscal year were as follows:

Classification of lands.....	\$199, 000
Supervision of leasing operations, public lands.....	270, 000
Supervision of leasing operations, Indian lands.....	95, 000
Supervision of naval-reserve operations.....	50, 000
Federal Power Commission.....	2, 250

616, 250

CORRESPONDENCE

During the year 26,187 letter requests for information or technical reports were received in the Washington office of the branch, together with 45,075 pieces of miscellaneous correspondence for filing or for transmission to the appropriate field office. Within the same period 18,933 letters and 18,800 pieces of miscellaneous correspondence were sent out.

In the several field offices 30,508 letters and 578,471 pieces of miscellaneous correspondence were received, and 41,239 letters and 354,847 pieces of miscellaneous correspondence were sent out.

PUBLIC INFORMATION SERVICE

The conservation branch supplies information to the public through personal interviews with callers, by distribution of publications, and by making available for inspection publications or manuscripts not of a confidential character. During the year there were 10,683 personal calls for information at the field offices, 1,502 publications were distributed, and 1,370 were consulted. The following publications and public releases were completed during the year:

- Ageton, R. V., Guides to ore finding in the Tri-State district: Press memorandum.
- Bryan, L. L., and Mansfield, G. R., Water-power resources of Snake River between Jackson Hole and Alpine, Wyo., with description of geology. Manuscript report and press memorandum.
- Bryan, L. L., and Piper, A. M., Water-power resources of Hoh River, Washington, with description of the geology. Manuscript report and press memorandum.
- Deeds, J. F., and Falck, Depue, Land-classification report on Utah, with map. Manuscript report and press memorandum.
- Dobbin, C. E., Structure-contour map of the Spindletop dome, Natrona County, Wyo. Press memorandum.
- Development map of the Bloomfield-Kutz Canyon oil and gas field, San Juan County, N. Mex. Press memorandum.
- Natural gases other than the hydrocarbons. Presented at the meeting of the American Association of Petroleum Geologists in Oklahoma City, Okla., in April, 1932.
- and Erdmann, C. E., Geologic and structure map of the Harley dome, Grand County, Utah. Press memorandum.
- Structure-contour map of the Montana plains. Press memorandum.
- Dyer, B. W., Conditions affecting mining development [of iron ore on Canyon Creek, Fort Apache Indian Reservation, Arizona]: U. S. Geol. Survey Bull. 821, pp. 69-70.
- Erdmann, C. E., and Schwabrow, J. R., Detailed geologic and engineering report on the Border-Red Coulee oil field, Montana-Alberta. Press memorandum for early release in the fiscal year 1933.
- Hoyt, W. G., Water utilization in Snake River Basin. Advance synopsis of U. S. Geol. Survey Water-Supply Paper 657, together with map showing irrigated and irrigable lands, developed and undeveloped power and reservoir sites, and electric transmission lines. Press memorandum.
- Hoyt, W. G., and Troxell, H. C., Forests and stream flow. Read before the American Society of Civil Engineers at its annual convention in Yellowstone Park, July 6, 1932.
- Jones, B. E., Developed water power of the world: Press memorandum.
- Jones, B. E., Oakey, Warren, and Stearns, H. T., Water-power resources of the Rogue River drainage basin, Oregon: U. S. Geol. Survey Water-Supply Paper 638, pp. 35-97.
- Jones, E. E., Water-power resources of Soleduck and Lyre Rivers, Washington. Manuscript report and press memorandum.

Patterson, R. C., Development of the Kettleman Hills North Dome field under the Kettleman North Dome Association. Read March 21, 1932, at meeting of Tulsa (Okla.) chapter Am. Inst. Min. and Met. Eng.

Smith, H. I., Potash mined in United States may meet all domestic needs: Oil, Paint, and Drug Reporter, June 29, 1931.

Stabler, Herman, History and purpose of classification of lands by the United States Geological Survey, with special reference to forest lands. Read before the Society of American Foresters at Washington, D. C., January 4, 1932.

Stabler, Herman, Holland, G. W., and Deeds, J. F., Rise and fall of the public domain, exclusive of Alaska and other outlying possessions. Read by Mr. Stabler before the American Society of Civil Engineers at its annual convention in Yellowstone Park, July 6, 1932.

Williams, C. F. (coauthor), Oklahoma lead and zinc district: Oklahoma Geol. Survey Bull. 56, 1932.

SUMMARY OF CASES

The activities in the Washington office with respect to land classification include the preparation of reports in response to requests for data or action on specific cases, the preparation of orders of withdrawal and restoration of lands not involved in specific requests, and the promulgation of broad areal classifications.

The following table summarizes activity with respect to requests for data or action on specific cases. The terms "gain" and "loss" signify, respectively, decrease and increase in the number of cases pending. The number of cases received was greater by 529 (4.1 per cent), and the number acted on was less by 1,861 (12.6 per cent) than during the preceding year. The number of cases pending at the end of the year was increased by about 21 per cent.

Summary of cases involving land classification

Class of cases	Record for fiscal year 1932						Record since receipt of first case	
	Pending July 1, 1931	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1932	Gain or loss during fiscal year	Received	Acted on
General Land Office requests:								
General.....	242	760	1,002	675	327	-85	-----	-----
Time extensions.....	-----	-----	-----	-----	-----	-----	2,313	2,313
Oil development.....	1	891	892	808	24	-23	17,086	17,062
Concurrence.....	17	745	762	750	12	+5	-----	-----
Sec. 27 cases.....	-----	39	39	-----	39	-39	39	-----
Committee cases—oil.....	72	1,948	2,020	1,873	147	-75	9,806	9,158
Applications for classification as to mineral:								
Oil.....	621	3,627	4,248	3,788	460	+161	21,193	20,733
Miscellaneous.....	4	16	20	16	4	-----	870	866
Applications for mineral permits.....	26	1,392	1,417	641	776	-751	54,507	53,731
Applications for mineral leases.....	10	125	135	133	2	+8	1,744	1,742
Applications for patent, potassium.....	-----	-----	-----	-----	-----	-----	124	124
Federal Power Commission cases:								
Preliminary permits.....	10	33	43	37	6	+4	229	223
Licenses.....	-----	-----	-----	-----	-----	-----	28	28
Determinations under sec. 24.....	8	41	49	41	8	-----	352	344
Applications for classification as to power resources.....	6	43	49	28	21	-15	491	470
Applications for agricultural classification.....	65	178	243	169	74	-9	1,207	1,133
Applications for rights of way.....	28	120	148	133	15	+13	6,749	6,734
Irrigation project reports.....	2	2	4	4	-----	+2	924	924
Applications under enlarged homestead acts.....	128	203	331	255	76	+82	57,671	57,595
Applications under stock-raising homestead acts.....	1,359	3,266	4,625	3,488	1,137	+222	137,308	136,171
Applications under ground-water reclamation act.....	7	6	13	12	1	+6	971	970
Indian Office requests for information.....	-----	2	2	2	-----	-----	9,547	9,547
	2,605	13,437	16,042	12,913	3,129	-524	-----	-----

SUMMARY OF FIELD OPERATIONS BY STATES

Alaska.—Supervised one power project. Expended \$8,000 through the Alaskan branch for supervision of 7 leases, 3 licenses, and 25 prospecting permits for coal and 142 prospecting permits for oil and gas. Coal produced, 101,168 tons; accrued rent and royalty, \$8,225.

Alabama.—Examined four tracts in Baldwin, Covington, Marion, and Marshall Counties for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State. Supervised 1 coal lease. Coal produced, 81,630 tons; accrued rent and royalty, \$8,163.

Arizona.—Supervised 11 power projects and surveyed 196 miles of river. Examined 18 tracts for agricultural classification. Supervised on public land 4 prospecting permits for coal, 1 lease and 5 prospecting permits for sodium, 1 prospecting permit for potash, and 91 prospecting permits for oil and gas. No production reported; accrued rent and royalty, \$203. Supervised on Indian land 6 Indian agency coal mines on 5 reservations, and under Navajo Executive order 14 leases for oil and gas. In cooperation with the topographic branch an area of approximately 6 square miles was mapped and 21 asbestos leases examined.

Arkansas.—Supervised 1 prospecting permit for coal and 15 for oil and gas. No production reported.

California.—Examined two tracts in Fresno and Kern Counties for mineral classification. In cooperation with the geologic branch continued a detailed geologic examination of the North, Middle, and South domes of the Kettleman Hills anticline in Kings and Kern Counties. Supervised 31 power projects and surveyed 17 miles of river. Examined 25 tracts for agricultural classification and continued detailed studies of grazing conditions in Mono Lake and Owens Valleys preparatory to administration of lands withdrawn by the act of March 4, 1931 (46 Stat. 1530). Supervised on public land 6 prospecting permits for coal, 15 prospecting permits for sodium, 4 leases and 5 prospecting permits for potash, 193 leases, 4 suspended preference rights to leases, and 427 prospecting permits for oil and gas. Coal produced, 72 tons; accrued rent and royalty, \$18. No potash was produced; 2 leases were conducting experimental work and 1 was producing sodium salts—production, 32,195 tons; accrued rent and royalty, \$12,969. Oil produced, 14,237,495.65 barrels; natural gas, 24,399,649,000 cubic feet; natural-gas gasoline, 55,896,426 gallons; accrued royalty, \$1,599,112. Supervised on naval petroleum reserves 25 leases for oil and gas—oil produced, 3,919,625.61 barrels; natural gas, 4,442,014 cubic feet; natural-gas gasoline, 18,539,144 gallons; accrued royalty, \$690,188.

Colorado.—Examined two tracts in Morgan and Weld Counties for mineral classification. In cooperation with the geologic branch continued a detailed geologic survey of the Julesburg Basin, in the east-central part of the State. Supervised 11 power projects. Examined 78 tracts for agricultural classification. Supervised on public land 86 leases, 4 licenses, 53 permits, and 15 awarded lease applications for coal, 2 prospecting permits for sodium, 1 prospecting permit for potash, and 24 leases, 2 suspended preference rights to leases, and 400 prospecting permits for oil and gas. Coal produced, 342,551 tons; accrued rent and royalties, \$49,136. Oil produced, 544,073 barrels; natural gas, 1,308,602 cubic feet; natural-gas gasoline, 13,992 gallons; accrued royalty, \$23,205. Supervised on Indian lands on 2 reservations, 2 coal mines and 6 leases for oil and gas. Began direct supervision of oil and gas operations and royalty accounting for production from Indian lands.

Florida.—Examined three tracts in Bay, Gadsden, and Walton Counties for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State.

Idaho.—In cooperation with the geologic branch continued a detailed geologic survey of the Afton quadrangle. Supervised 6 power projects. Investigated power-site reserves on the Coeur d'Alene River. Examined 79 tracts for agricultural classification. Supervised on Indian lands on 2 reservations 2 coal mines and 6 leases for phosphate, 65 prospecting permits for oil and gas. Coal produced, 3,229 tons; phosphate, 33,050 tons; accrued rent and royalty, \$5,086.

Kansas.—Supervised 1 prospecting permit for oil and gas.

Louisiana.—Examined six tracts in Bossier, Caddo, Catahoula, and Winn Parishes for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State. Supervised 10 leases and 1 prospecting permit for oil and gas. Oil produced, 2,984 barrels; natural gas, 982,216,000 cubic feet; natural-gas gasoline, 34,067 gallons; accrued royalty, \$3,821.

Mississippi.—Examined seven tracts in Attala, Choctaw, George, Greene, Jackson, and Wayne Counties for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State.

Montana.—Examined three tracts in Carter County for mineral classification and one tract in Carbon County for reclassification as to coal. Made structural and stratigraphic investigations in eastern Montana for preparation of structure-contour map of Cedar Creek anticline. In cooperation with geologic branch completed a geologic investigation for phosphate classification near Avon; also continued through that branch a detailed investigation of the coal resources of Custer and Powder River Counties. Supervised 29 power projects and surveyed 120 miles of river. Examined 59 tracts for agricultural classification. Supervised on public land 77 leases, 56 licenses, 40 prospecting permits, and 21 awarded lease applications for coal; 2 phosphate leases; 76 leases, 1 suspended preference right to lease, and 478 prospecting permits for oil and gas. Coal produced, 192,432 tons; accrued rent and royalty, \$23,489. Oil produced, 375,568 barrels; natural gas, 1,639,101,000 cubic feet; accrued royalty, \$39,362. Supervised on Indian lands on 2 reservations, 142 leases for oil and gas. Began direct supervision of oil and gas operations and royalty accounting for production from Indian lands.

Nebraska.—Supervised 3 prospecting permits for potash. Examined 2 tracts for agricultural classification.

Nevada.—Supervised 6 power projects. Examined 21 tracts for agricultural classification and continued regional investigations of agricultural utility precedent to grazing classification in the northeastern part of the State. Supervised 6 prospecting permits for coal, 1 lease and 5 prospecting permits for sodium, 1 lease for phosphate, and 49 prospecting permits for oil and gas. Sodium produced, 700 tons; phosphate, 40 tons; accrued rents and royalties, \$80.

New Mexico.—Made areal, structural, and economic reconnaissance with reference to coal, oil, and gas in northern and western parts of San Juan Basin. Continued through geologic branch similar investigations in southern and eastern parts of the basin. Supervised 3 power projects. Examined 60 tracts for agricultural classification. Supervised on public land 25 leases, 51 prospecting permits, and 1 awarded lease application for coal; 9 prospecting permits for sodium; 6 leases and 124 prospecting permits for potash; 63 leases, 17 suspended preference rights to leases, and 897 prospecting permits for oil and gas. Coal produced, 45,415 tons; potash, 45,967 tons; accrued rent and royalty, \$18,807. Oil produced, 1,683,880 barrels; natural gas, 7,749,785,000 cubic feet; natural-gas gasoline, 1,197,131 gallons; accrued royalty, \$70,666. Supervised on Indian land on 6 reservations, 15 coal mines and 32 leases for oil and gas. Began direct supervision of oil and gas operations and royalty accounting for production from Indian lands.

North Dakota.—Examined 5 tracts for agricultural classification. Supervised 66 leases, 25 licenses, 1 prospecting permit, and 13 awarded lease applications for coal, 4 prospecting permits for sodium, and 18 prospecting permits for oil and gas. Coal produced, 427,199 tons; accrued rent and royalty, \$25,235.

Oklahoma.—Supervised 1 power project. Supervised on public land 17 leases and 5 prospecting permits for oil and gas. Oil produced, 185,900 barrels; natural-gas gasoline, 69,399 gallons; accrued rent and royalty, \$17,608. Supervised on Indian lands on 21 reservations 78 coal leases, 2 leases for volcanic ash, 40 leases for lead and zinc, and 5,887 leases for oil and gas. Made 4,783 field investigations of Indian lands for regulatory, inspectional, and appraisal purposes. Coal produced on Indian lands, 459,848 tons; lead and zinc concentrates produced, 37,537 tons; market value, \$896,305. Royalties from production accrued, oil, \$1,805,932; dry gas, \$41,992; casing-head gas, \$52,992.

Oregon.—Investigated storage and power possibilities on the Walla Walla River and surveyed 80 miles of river. Examined 31 tracts for agricultural classification. Supervised 4 power projects. Supervised 2 leases and 9 prospecting permits for coal, 1 lease for oil shale, 3 prospecting permits for potash, and 15 prospecting permits for oil and gas. Coal produced, 1,369 tons; accrued rents and royalties, \$3,054.

South Dakota.—Examined 5 tracts for agricultural classification. Supervised 4 leases for coal and 15 prospecting permits for oil and gas. Coal produced, 2,153 tons; accrued rent and royalty, \$374.

Utah.—Made structural and stratigraphic investigations of Harley dome, Grand County, for preparation of structure-contour map. Supervised 8 power projects. Examined 48 tracts for agricultural classification. Supervised on

public land 45 leases, 2 licenses, and 65 prospecting permits for coal, 36 prospecting permits for potash, and 12 leases, 2 suspended preference rights to leases, and 522 prospecting permits for oil and gas. Coal produced, 767,553 tons; accrued rent and royalty, \$125,437. Oil produced, 6,695 barrels; natural gas (including carbon dioxide), 44,949,000 cubic feet; accrued royalty, \$713. Supervised on Indian land on one reservation 4 agency coal mines and under Executive order 6 leases for oil and gas.

Washington.—Supervised 10 power projects and surveyed 50 miles of river. Investigated storage and power possibilities on the Queets, Duckabush, and Dosewallips Rivers. Examined 7 tracts for agricultural classification. Supervised 21 prospecting permits for coal and 1 prospecting permit and 1 awarded lease application for sodium. Coal produced, 44,190 tons; accrued rent and royalty, \$11,071.

Wyoming.—Remapped basal Mesaverde coal in Kindt Basin, Carbon County, to conform with township resurveys. Investigated storage and power possibilities and surveyed 65 miles of the Snake River and supervised 4 power projects. Examined 110 tracts for agricultural classification and completed in the western part of the State regional investigations precedent to grazing classification. Supervised on public land 39 leases, 11 licenses, 41 prospecting permits, and 5 awarded lease applications for coal, 2 prospecting permits for sodium, 1 prospecting permit for potash, and 397 leases, 8 suspended preference rights to leases, and 845 prospecting permits for oil and gas. Made 149 analyses of water, 31 of oil, and 41 of oil and gas, and 27,989 determinations of oil gravity. Coal produced, 871,486 tons; accrued rent and royalty, \$112,176. Oil produced, 9,417,622 barrels; natural gas, 14,752,514,000 cubic feet; natural-gas gasoline, 40,726,823 gallons; accrued royalty, \$1,340,988. Made periodic inspection and pressure test of wells shut in on Naval Petroleum Reserve No. 3 and supervised operations for mudding and plugging certain wells that were in unsatisfactory condition. Supervised on Indian land on one reservation 40 leases for oil and gas. Began direct supervision of oil and gas operation and royalty accounting for production from Indian lands.

MINERAL CLASSIFICATION DIVISION

The work of mineral classification involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation relative to mineral classifications and to orders of withdrawal, modification, and restoration. The results of these field investigations take the form of reports concerning the mineral character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public land, Indian land, and naval oil reserves.

During the fiscal year requests for reports on the prospective value for oil and gas of lands involved in certain types of nonmineral entries and filings totaled 4,248, and reports on 3,788 cases were submitted to the General Land Office.

Some progress was made in 1931 in classifying the vast areas of public land that are still embraced in mineral withdrawals. The results accomplished include net decreases of 816,873 acres in outstanding withdrawals for coal, of 54,100 acres in areas classified as oil-shale land, and of 115,293 acres in outstanding withdrawals for phosphate, and net increases of 508,480 acres in areas classified as coal and of 1,737 acres in areas classified as phosphate.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

*Summary of outstanding mineral withdrawals and classifications June 30, 1932,
in acres*

State	Coal		Oil	
	Withdrawn	Classified as coal land	Withdrawn	Classified as oil land
-----	139,415	56,993	356	-----
Ala.-----	17,603	61,160	-----	-----
Ark.-----	4,142,233	8,720	1,178,392	-----
Cal.-----	4,761	3,082,272	215,370	-----
Col.-----	-----	4,603	-----	-----
Del.-----	-----	-----	466,980	4,223
Fla.-----	7,047,068	9,072,342	1,336,697	67,651
Idaho-----	83,673	-----	-----	-----
Ill.-----	5,061,011	570,372	-----	-----
Iowa-----	5,954,364	11,178,286	84,894	-----
Kan.-----	4,361	18,887	-----	-----
La.-----	-----	250,083	-----	-----
Mont.-----	3,404,045	1,267,697	1,341,264	-----
Neb.-----	691,801	141,444	-----	-----
N.M.-----	2,260,604	6,740,564	541,777	-----
-----	28,810,937	32,453,463	5,165,740	71,894

State	Oil shale		Phosphate		Potash, with- drawn
	With- drawn	Classified as oil shale land	With- drawn	Classified as phos- phate land	
Ala.-----	-----	-----	-----	-----	90,834
Ark.-----	64,560	952,239	-----	-----	-----
Cal.-----	-----	-----	66,796	120	-----
Col.-----	-----	-----	276,230	270,086	-----
Fla.-----	-----	-----	279,944	3,833	-----
Idaho-----	128	-----	-----	-----	39,422
Ill.-----	-----	-----	-----	-----	9,282,160
Iowa-----	91,464	2,703,785	277,844	2,937	-----
Kan.-----	-----	406,006	969,149	26,266	-----
-----	156,147	4,061,997	1,899,472	302,219	9,411,906

includes 2,151 acres of coal land reserved for use of the United States (Coal Reserve No. 1).
includes 2,078 acres of coal land reserved for use of the United States (Coal Reserve No. 2).

The following table summarizes the year's work to the extent that involved technical reports on filings under the mineral-leasing

Summary of applications under the mineral-leasing laws, fiscal year 1932

[Includes cases pending July 1, 1931]

Mineral	Prospecting permits		Leases		Relinquishments and cancellations		Reinstatements and extensions	
	Received	Acted on	Received	Acted on	Received	Acted on	Received	Acted on
gas-----	1,156	382	-----	-----	892	868	2,020	1,873
oil-----	160	160	110	108	-----	-----	-----	-----
-----	-----	-----	13	13	-----	-----	-----	-----
-----	16	16	2	2	-----	-----	-----	-----
-----	85	84	10	10	-----	-----	-----	-----
-----	1,417	641	135	133	892	868	2,020	1,873

In accordance with the duty delegated to the Geological Survey, definitions of the "known geologic structure" of 20 producing oil and gas fields were prepared and promulgated during the year, as follows:

Definitions of "known geologic structure," fiscal year 1932

State	Field	Date promulgated	Acres
Colorado.....	Powder Wash.....	June 20, 1932	4,923
New Mexico.....	Hobbs.....	Dec. 16, 1931	16,000
Do.....	North Eunice.....	do.....	4,110
Do.....	South Eunice.....	do.....	15,730
Do.....	Balish.....	May 23, 1932	2,640
Do.....	Compton.....	do.....	800
Do.....	Empire.....	do.....	443
Do.....	Getty.....	do.....	2,000
Do.....	Grayburg.....	do.....	1,022
Do.....	Jackson.....	do.....	6,200
Do.....	Lea.....	do.....	1,021
Do.....	Leonard-Levers.....	do.....	2,440
Do.....	Mitchell.....	do.....	2,357
Do.....	Fecos Valley.....	do.....	1,673
Do.....	Robinson.....	do.....	2,053
Do.....	Skelly.....	do.....	1,400
Wyoming.....	Big Sand Draw (additional).....	Feb. 25, 1932	00
Do.....	Osage (additional).....	June 22, 1932	3,400
Do.....	Midway.....	June 1, 1932.....	5,021
Do.....	Hamilton Dome (elimination).....		9,700

The net area included in outstanding definitions of the "known geologic structure" of producing oil and gas fields on June 30, 1932, was 843,106 acres, in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Geologic field work required in the solution of the problems of the branch is performed in part by summer detail of Washington employees of the mineral-classification division, in part by two division geologists and two assistants with headquarters in Denver, Colo., and in part by the geologic branch at the expense of the conservation branch. Investigations during the fiscal year 1932 are included in the summary of field operations by States beginning on page 62.

Reports were submitted during the year for administrative use concerning the Manuelito coal field, McKinley County, N. Mex.; the structure and coal resources of the Hospah-Seven Lakes-Stony Butte region, San Juan and McKinley Counties, N. Mex.; the Cuthank gas area, Glacier County, Mont.; the Bowdoin gas field, Phillips and Valley Counties, Mont.; and the geologic disclosures of well No. 1 Gerard of the Fulton Blackfeet Oil Co., on the Milk River anticline, Glacier County, Mont.

POWER DIVISION

The work of power classification consists primarily in obtaining and making available for use in the administration of the public-land laws information as to the water-power resources of the public lands. The extent of this task is indicated by the fact that areas aggregating nearly 7,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches. The field projects under-

taken during the year are included in the summary of field operations by States (pp. 62-64).

Copies of many of the reports on the power possibilities of the streams examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press.

River surveys to the aggregate length of 528 miles were made of the Salt River and its tributaries and the Black and White Rivers, Ariz.; the Walla Walla River in Oregon and Washington; the North Fork of the Nooksak River, Wash., from Maple Falls to the mouth of Ruth Creek; Glacier Creek, Wash., from the mouth to the 2,000-foot contour crossing; a section of the Queets River, Wash.; the Judith River, Mont., from the mouth to Big Spring Creek; Big Spring Creek to Big Springs and Warm Spring Creek to Warm Springs; and Snake River, Wyo. Four dam-site surveys were made in Oregon, two in Washington, and one in Montana; and reconnaissance geologic examinations were made at seven dam sites in Oregon and two in Washington.

Reports were obtained on field inspections of 26 power projects under permit from the Interior Department.

Administration of the field supervision of power projects for the Federal Power Commission is carried on in this office. Investigations and reports have been made on 19 projects, construction and operation are supervised on 125 projects, and cost accounting is being supervised on 10 projects.

The work of the division is briefly summarized in the accompanying tables and in the general summary on pages 62-64.

Pursuant to instructions of the Secretary of the Interior, dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), were called upon for detailed reports of the operation or development of their power systems during the calendar year 1931. The total installation of the reporting companies is 3,608,000 horsepower, of which 2,353,000 horsepower is at hydraulic plants and 1,255,000 horsepower at fuel plants. The total energy generated was 7,696,000,000 kilowatt-hours, which was 154,000,000 kilowatt-hours less than in 1930 and was the smallest output since 1925. The energy generated by water power decreased 1,557,000,000 kilowatt-hours, or nearly 23 per cent; and that generated by fuel increased 1,403,000,000 kilowatt-hours, or nearly 143 per cent. The unusually low stream flow during 1931 is reflected in the large increase in the electric energy generated by fuel.

Power output of permittees and grantees, 1916-1931

Calendar year	Kilowatt-hours	Increase or decrease		Calendar year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1916.....	1,200,000,000			1924.....	6,100,000,000	+190,000,000	+3
1917.....	2,000,000,000	+800,000,000	+67	1925.....	6,930,000,000	+830,000,000	+14
1918.....	3,200,000,000	+1,200,000,000	+60	1926.....	7,800,000,000	+870,000,000	+13
1919.....	3,100,000,000	-100,000,000	-3	1927.....	8,116,000,000	+316,000,000	+4
1920.....	4,300,000,000	+1,100,000,000	+35	1928.....	8,987,000,000	+871,000,000	+11
1921.....	3,725,000,000	-575,000,000	-13	1929.....	9,352,000,000	+365,000,000	+4
1922.....	4,947,000,000	+1,222,000,000	+33	1930.....	7,850,000,000	-1,502,000,000	-16
1923.....	5,910,000,000	+963,000,000	+19	1931.....	7,696,000,000	-154,000,000	-2

The following table shows the revenue accrued for occupancy and use of public lands by the power projects mentioned above:

Accrued compensation for occupancy and use of lands under power permits and grants issued by the Interior Department, 1912-1932

State	1912-1915	1916-1920	1921-1925	1926-1930	1931	1932
Alaska.....		\$6,960	\$9,280	\$2,900	\$580	\$880
Arizona.....	\$515	1,285	1,900	1,900	400	400
California.....	3,619	9,274	9,918	9,694	1,942	1,900
Colorado.....	315	875	1,765	1,465	250	200
Idaho.....	20	1,670	1,700	1,640	310	200
Montana.....	1,255	7,562	13,314	28,183	7,487	7,800
Nevada.....	281	2,245	2,570	3,565	1,443	1,427
New Mexico.....		20	60	275	95	95
Oregon.....	60	100	700	700	225	225
Utah.....		2,568	4,395	4,400	1,150	1,181
Washington.....	15	156	631	3,675	1,266	1,300
Wyoming.....		70	175	290	65	65
Minnesota.....		20	25	20		
Accumulation.....	6,080 6,080	32,805 38,885	46,433 85,318	58,697 144,015	15,274 159,289	15,000 174,328

Accrued charges for the unauthorized occupancy of public lands by power projects prior to the issuance of licenses therefor by the Federal Power Commission amount to \$109,863.61, of which \$12,222.28 is before the courts for adjudication.

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat., 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1931	Eliminated prior to July 1, 1931	Outstanding prior to July 1, 1931	Reserved during fiscal year	Eliminated during fiscal year	Outstanding June 30, 1932
Alabama.....	2,377		2,377	56		2,433
Alaska.....	316,319	32,164	284,155	9,352	1,479	292,028
Arizona.....	1,338,878	141,197	1,197,681	12		1,197,693
Arkansas.....	29,718	440	29,278	2,169		31,447
California.....	1,466,037	53,829	1,412,208	13,352	490	1,425,069
Colorado.....	559,112	98,829	460,283	3,041	475	462,849
Florida.....	1,131		1,131			1,131
Idaho.....	653,511	204,752	448,759	202	2,439	446,522
Michigan.....	1,246		1,246			1,246
Minnesota.....	19,062	532	18,530			18,530
Mississippi.....	3		3			3
Missouri.....	11		11	40		51
Montana.....	308,429	99,923	208,506	429	23	208,502
Nebraska.....	761		761			761
Nevada.....	360,679	1,845	358,834	303		359,137
New Mexico.....	272,980	16,123	256,857			256,857
Oregon.....	820,724	187,259	633,465	15,399	3,705	645,159
South Dakota.....	796		796			796
Utah.....	786,245	137,342	648,903	1,601	1,900	648,604
Washington.....	480,526	108,857	371,669	3,721		375,390
Wisconsin.....	1,906	226	1,680			1,680
Wyoming.....	275,805	76,465	199,340	2,048	481	200,967
	7,696,256	1,159,783	6,536,473	51,695	10,983	6,577,185

Summary of outstanding water-resources withdrawals and classifications, June 30, 1932, in acres

State	Power reserves					Reservoir withdrawals	Public water reserves
	Withdrawals	Classifications	Designations *	Miscellaneous	Total		
Alabama.....	120	1,735		578	2,433		
Alaska.....	88,275	117,666		86,087	292,028		8
Arizona.....	373,899	49,861	524,200	249,733	1,197,693	23,040	21,700
Arkansas.....	21,954	1,550		7,943	31,447		
California.....	286,915	377,703		760,462	1,425,080	45,264	200,871
Colorado.....	210,044	193,558		59,247	462,849	1,728	11,330
Florida.....				1,131	1,131		
Idaho.....	193,592	234,098		18,832	446,522		17,502
Michigan.....	1,240			6	1,246		
Minnesota.....	12,309			6,221	18,530		
Mississippi.....				3	3		
Missouri.....				51	51		
Montana.....	126,971	55,827		26,114	208,912	9,080	10,457
Nebraska.....	761				761		
Nevada.....	26,627	86,905		245,605	359,137		16,221
New Mexico.....	115,647	49	141,161		256,857		10,116
North Dakota.....						1,091	
Oregon.....	316,426	218,362	14,532	95,808	645,128	18,603	29,021
South Dakota.....				796	796		240
Utah.....	433,335	178,126		37,143	648,604	80	40,385
Washington.....	102,283	193,320		79,787	375,390	31,797	920
Wisconsin.....				1,680	1,680		
Wyoming.....	79,624	77,563		43,720	200,907	1,714	89,065
	2,390,022	1,786,323	679,893	1,720,947	6,577,185	132,397	447,836

* Designated and not otherwise withdrawn.

AGRICULTURAL DIVISION

The principal functions of the agricultural division consist of the classification of lands under the enlarged homestead law as nonirrigable; the classification of lands under the Nevada ground-water reclamation law as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family; and the preparation of reports showing the agricultural utility of lands in important public-land regions, including a classification of the grazing lands as to forage types and yields and suggestions as to the proper use thereof to maintain a natural ground cover, prevent waste of the forage growth by overgrazing, and incidentally eliminate avoidable erosion losses.

Classifications are made in accordance with the results of field examinations by members of the division and with information obtained from other sources. The work of the division is planned with the primary purpose of acting on pending applications for classification under the above-mentioned laws and to provide in advance the basis for appropriate action on new applications. The number of cases received and acted on during the fiscal year is shown in the

general summary of cases (p. 61). There was a decrease of about 18 per cent in the number received, and the arrearage was 17 per cent less at the end of the year than at the end of the fiscal year 1931.

Summary of enlarged-homestead designations, in acres

[Areas classified as arid and nonirrigable, residence by entrymen required, act of February 19, 1909 (38 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1920 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 132), applicable to California, North Dakota; act of March 3, 1915 (38 Stat. 953), applicable to Kansas; act of March 4, 1915 (38 Stat. 1163), applicable to South Dakota. Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required, act of February 19, 1909 (38 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho]

State	Designations prior to July 1, 1931	Cancellations prior to July 1, 1931	Outstanding prior to July 1, 1931	Designations during fiscal year	Cancellations during fiscal year	Outstanding June 30, 1932
Arizona	31, 534, 184	13, 380, 029	18, 154, 155	730	40, 540	18, 114, 345
California	13, 384, 547	457, 333	12, 927, 214	1, 413	1, 801, 070	11, 127, 527
Colorado	33, 978, 782	196, 428	33, 782, 354	1, 713		33, 784, 067
Idaho						
Total	13, 758, 156	461, 725	13, 296, 431	3, 480		13, 299, 911
Nonresidence	573, 707	4, 233	569, 474	200		569, 274
Kansas	652, 404		652, 404	716		653, 120
Montana	53, 496, 956	245, 728	53, 251, 228	25, 360	360	53, 276, 228
Nevada	50, 219, 304	3, 581, 037	46, 638, 267			46, 638, 267
New Mexico	43, 854, 836	228, 012	43, 626, 824	5, 070	25, 596	43, 606, 298
North Dakota	12, 282, 557	3, 848	12, 278, 709			12, 279, 043
Oregon	21, 284, 551	1, 001, 222	20, 283, 329	840		20, 284, 169
South Dakota	16, 343, 341	348, 170	15, 995, 171	1, 092		15, 996, 263
Utah						
Total	11, 757, 297	1, 197, 827	10, 559, 470	1, 120	1, 480	10, 560, 110
Nonresidence	1, 658, 098	509, 103	1, 148, 995	560	760	1, 148, 795
Washington	6, 661, 092	251, 842	6, 409, 250	600		6, 409, 850
Wyoming	29, 791, 769	162, 043	29, 629, 726	4, 040	1, 313, 130	28, 320, 636
	338, 999, 776	21, 515, 244	317, 484, 532	46, 510	3, 182, 176	314, 348, 896

* 80 acres previously designated under secs. 1-5, now under sec. 6.

Summary of stock-raising homestead designations, in acres

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family (act of Dec. 29, 1916; 39 Stat. 862)]

State	Designations prior to July 1, 1931	Cancellations prior to July 1, 1931	Outstanding prior to July 1, 1931	Designations during fiscal year	Cancellations during fiscal year	Outstanding June 30, 1932
Arizona	14, 273, 509	1, 037, 930	13, 235, 579	65, 663	2, 120	13, 299, 122
Arkansas	1, 120		1, 120			1, 120
California	8, 186, 239	11, 440	8, 174, 799	69, 386	20, 600	8, 223, 585
Colorado	9, 389, 597	21, 080	9, 368, 517	179, 370	1, 000	9, 546, 967
Florida	480	480				
Idaho	5, 737, 152	2, 014	5, 735, 138	38, 460	1, 854	5, 771, 744
Kansas	116, 299		116, 299	440		116, 739
Michigan	3, 491		3, 491			3, 491
Minnesota				80		80
Mississippi	160		160			160
Montana	15, 949, 751	51, 201	15, 898, 550	151, 236	280	16, 049, 506
Nebraska	212, 759		212, 759	2, 720		215, 479
Nevada	656, 842	3, 120	653, 722	14, 791		668, 513
New Mexico	31, 893, 391	28, 116	31, 865, 275	218, 668	4, 060	32, 074, 363
North Dakota	404, 407		404, 407	9, 988		414, 395
Oklahoma	89, 130		89, 130	1, 233		90, 363
Oregon	6, 496, 730	3, 168	6, 493, 562	45, 005	80	6, 538, 467
South Dakota	6, 548, 130	550	6, 547, 580	5, 190		6, 552, 770
Utah	2, 167, 377	8, 275	2, 159, 102	112, 199	840	2, 270, 461
Washington	713, 668	1, 294	712, 374	6, 395		718, 769
Wyoming	21, 114, 887	7, 733	21, 107, 154	196, 948	264, 100	21, 040, 000
	123, 955, 119	1, 176, 401	122, 778, 718	1, 112, 822	294, 964	123, 596, 580

By blanket order of withdrawal creating Public Water Reserve No. 107, which received Executive approval April 17, 1926, every smallest legal subdivision of the public-land surveys that is vacant unappropriated public land and contains a spring or water hole and all land within a quarter of a mile of every spring or water hole located on unsurveyed public land were reserved for public use and in aid of pending legislation. This order obviated the necessity for future withdrawals of specific tracts containing springs or water holes valuable for stock watering, but it requires a determination with respect to all entries of public land whether or not any of the subdivisions involved are in fact affected by it. On the basis of such determination, orders of interpretation are issued from time to time, listing by legal subdivisions of the public-land survey any tracts found to contain a water supply affected by the order. New withdrawals of this type are made to reserve lands along streams and are also made from time to time for special public purposes. The extent of outstanding reserves of this type and of current action affecting them is shown in the following table:

Public water reserves, in acres

[Includes areas withdrawn under the act of June 25, 1910 (41 Stat. 1063), as amended by the act of Aug. 24, 1912 (37 Stat. 497), and reserved for public use of springs or water holes in accordance with the provisions of sec. 10 of the act of Dec. 29, 1916 (39 Stat. 862), or for watershed protection, drainage reservoirs, or other similar miscellaneous public purposes involving water conservation]

State	Reserved prior to July 1, 1931	Eliminated prior to July 1, 1931	Outstand- ing prior to July 1, 1931	Reserved during fiscal year	Eliminated during fiscal year	Outstand- ing June 30, 1932
Alaska.....				8		8
Arizona.....	23, 677	2, 742	20, 935	1, 125	360	21, 700
California.....	207, 929	7, 898	200, 031	840		200, 871
Colorado.....	10, 805	940	9, 865	1, 965		11, 330
Idaho.....	17, 507	410	17, 097	445	40	17, 502
Montana.....	11, 529	1, 552	9, 977	520	40	10, 457
Nevada.....	19, 151	3, 615	15, 536	685		16, 221
New Mexico.....	13, 041	3, 095	9, 946	160		10, 116
Oregon.....	29, 859	1, 568	28, 291	720		29, 021
South Dakota.....	240		240			240
Utah.....	47, 646	7, 596	40, 050	495	160	40, 385
Washington.....	920		920			920
Wyoming.....	100, 165	14, 220	85, 945	3, 120		89, 065
	481, 979	43, 626	438, 353	10, 083	600	447, 836

In the field broad areal studies were continued in the Colorado Basin region, a land-classification report for western Colorado is nearing completion, and field studies were completed preliminary to the preparation of land-classification maps for western Wyoming. Intensive grazing studies were made in Mono Lake and Owens Valleys, Calif., preparatory to the administration of lands withdrawn under the act of March 4, 1931 (46 Stat. 1530). A special land-classification report and map was completed for Utah showing irrigated and dry-farming land, together with different range types and a summary of the aggregate forage resources as compared with the livestock population.

W. G. Hoyt, J. F. Deeds, Depue Falck, G. M. Kerr, and J. Q. Peterson served on subcommittees of a National Land Use Planning Committee, organized at the instance of the Secretary of Agriculture to study economic problems arising in connection with the various uses of land in the United States.

During the fiscal year the area designated under the Nevada ground-water reclamation act was increased 6,560 acres, to a total of 1,706,535 acres. Outstanding withdrawals under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, aggregating 61,397 acres, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

MINING AND OIL AND GAS LEASING DIVISIONS

WORK OF THE DIVISIONS

The work of the mining and oil and gas leasing divisions is supervisory (both inspectional and regulatory) with respect to operations on the public domain for the discovery and development of petroleum, natural gas, oil shale, coal, phosphate, sodium, potassium, and sulphur; on certain land grants for gold, silver, and mercury; on naval petroleum reserves for petroleum and natural gas; and on Indian lands for coal, oil and gas, zinc, lead, iron, silver-lead, uranium, vanadium, and radium ores, vermiculite, asbestos, asphalt, volcanic ash, and stone. This work is done with a minimum of administrative supervision from Washington through district offices at or near the primary centers of mining or drilling activity, under the direction of responsible engineers who have full authority to represent the Secretary within their jurisdiction and to order compliance with the law and regulations under which operations are conducted.

BENEFITS DERIVED FROM MINERAL LEASING

Since October 20, 1914, the date of approval of the law providing for the leasing of coal lands in Alaska, \$72,801,387 has accrued from royalties, rentals, and bonuses by reason of mineral production on public land. During the past fiscal year \$3,501,471 accrued from 5,695 leases, licenses, and prospecting permits, involving more than 8,300,000 acres of land in 19 States and Alaska.

Under the mineral leasing act of 1920 the public-land States receive, without expense, 37.5 per cent of all money derived from leases and permits within their respective borders and participate in the benefits resulting from the expenditure of an additional 52.5 per cent of the income by the Bureau of Reclamation. Incidental benefits include taxes on production and on property used in the development of leases, which in some States amount to more than one-fifth of the total income from taxes. Only 10 per cent of the income from mineral-leasing operations is retained in the United States Treasury. Though the expenditures of the United States on account of the public lands far exceed this 10 per cent retained, the reserved mineral deposits bring in a revenue about twenty times all costs of classification and administration.

Alaska, by special legislation, receives all net profits from the operation of Government mines and all royalties and rentals from mineral leases. The money thus derived is applied to the reimbursement of the Federal Government for the construction of railroads in that Territory.

MINING OPERATIONS ON PUBLIC LANDS

At the end of the fiscal year the inspection of mining and prospecting operations was more nearly up to date, and the conditions of the mines in regard to safety and welfare of the workmen and to the ultimate extraction of the maximum amount of coal were at a higher standard, than at any previous time. These results were accomplished by regular though altogether too infrequent inspections and by gaining the confidence of the operators, most of whom are willingly complying with the operating regulations. Operators on fee land as well as operators on leased land make frequent requests for suggestions in regard to better mining practice.

During the fiscal year 279 leases, licenses, and prospecting permits were issued, involving 325,230.28 acres, as compared with 232, involving 227,988.81 acres, in the fiscal year 1931.

Leases, licenses, and permits issued, fiscal year 1932

	Number	Acres		Number	Acres
Leases:			Permits:		
Coal.....	33	3,330.72	Coal.....	81	71,055.67
Potash.....	3	6,908.59	Potash.....	102	218,938.78
Phosphate.....	1	120.00	Phosphate.....		0
Sodium.....	0	0	Sodium.....	13	23,238.64
	37	10,259.31		196	313,223.04
Licenses.....	46	1,747.93	Grand total.....	279	325,230.28

During the same period 24 coal leases, 18 coal permits, 2 coal licenses, 4 potash permits, 1 sodium lease, and 1 sodium permit were canceled, and 69 coal permits, 8 coal licenses, 29 potash permits, and 24 sodium permits expired by limitation—a total of 180 for 1932 as compared with 156 for 1931.

The following table shows the total number of leases, licenses, and permits involving public land under supervision at the end of the year:

Mining leases, licenses, and permits on the public domain under supervision of the Geological Survey June 30, 1932

State	Coal						Potash			
	Leases		Permits		Licenses		Leases		Permits	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Alaska.....	6	7,027.28	20	40,479.96	3	30.00				
Alabama.....	1	1,840.00								
Arizona.....			1	2,079.88					1	694.77
Arkansas.....			3	6,012.64			4	7,783.80	5	10,870.19
California.....			39	25,037.45	4	160.00			1	2,150.00
Colorado.....	77	11,665.54	11	9,877.57						
Idaho.....			35	7,255.98	51	1,992.82				
Montana.....	76	6,791.34							2	300.00
Nebraska.....			5	8,724.04					3	6,413.05
Nevada.....			28	40,032.07			6	14,482.98	105	228,644.46
New Mexico.....	22	11,483.48	1	120.00	20	880.00			2	4,488.94
North Dakota.....	60	6,582.36	9	6,746.38						
Oregon.....	2	1,895.24								
South Dakota.....	4	239.04	65	83,392.00	2	160.00			36	77,441.90
Utah.....	41	27,220.83	17	14,420.86						
Washington.....			37	26,260.17	11	440.00				
Wyoming.....	34	12,802.71								
	323	87,547.82	271	270,439.00	91	3,662.82	10	22,266.78	155	331,003.31

Mining leases, licenses, and permits on the public domain under supervision of the Geological Survey June 30, 1932—Continued

State	Sodium				Phosphate		Oil shale	
	Leases		Permits		Leases		Leases	
	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres	Num- ber	Acres
Arizona.....	1	405.20	5	6,933.96				
California.....			7	12,204.33				
Idaho.....					2	1,700.00		
Montana.....					2	1,400.00		
Nevada.....	1	1,440.00	6	12,080.13	1	160.00		
New Mexico.....			6	10,619.19				
North Dakota.....			1	520.00				
Oregon.....							1	2,600.00
	2	1,845.20	25	42,357.61	5	3,260.00	1	2,600.00

Total leases, 341; licenses, 91; permits, 451.

During the year the number of operating mines of all kinds was increased by 52. The number of coal mines was increased from 382 to 432, there being a decrease of 12 shipping mines and an increase of 62 wagon mines. The phosphate and sodium operations were each increased from 3 to 4. The number of potash operations remained the same. A total of 1,448 inspections of leases, licenses, and permits were made at an average cost of \$31.57 per inspection, which includes all expenditures of the districts. An average of 175 inspections were made by each field engineer.

Operating mines, fiscal year 1932

State	Phos- phate	Potash	Sodium	Coal		Total
				Shipping	Wagon	
Alaska.....				4		4
Alabama.....				1		1
Arizona.....			1			1
California.....			2		1	3
Colorado.....				14	63	77
Idaho.....	2				6	8
Montana.....	1			3	129	133
Nevada.....	1		1			1
New Mexico.....		1		5	12	18
North Dakota.....				6	66	72
Oregon.....					3	3
South Dakota.....					4	4
Utah.....				17	32	49
Washington.....				1		1
Wyoming.....				16	49	65
	4	1	4	67	365	441

Thirty-nine prospect wells, drilled to a total depth of 29,931 feet, were supervised during the year, as compared to 25 wells, with a total depth of 10,902 feet, supervised during the previous year.

Production.—The value of the minerals produced on public lands during the year, at prevailing market prices, was \$7,880,454 divided as follows: Coal, \$6,502,304; phosphate, \$115,806; potash, \$759,071; sodium, \$503,273. There was no production or development of oil shale or sulphur prior to or during the year.

Coal.—At the end of the year there were in effect 323 coal leases, 91 coal licenses, and 271 coal permits involving 361,649.64 acres. During the year 2,880,447.89 tons of coal was produced from public lands in 12 States and Alaska, from which \$375,939 accrued in rents, royalties, and bonuses. There was a decrease in production of 5 per cent from the preceding year, but the number of mines increased 13 per cent. Four test holes were drilled to a total depth of 3,255 feet.

Of the 24 coal mines in the United States receiving awards from the Joseph A. Holmes Safety Association for production without a fatality during 1932 the following were operated on leased public lands: Liberty Fuel Co., 1,018,000 tons; No. 4 mine, Union Pacific Coal Co., 2,476,122 tons; C mine, Union Pacific Coal Co., 1,019,758 tons; Hotchkiss mine, Hotchkiss Coal Co., 672,107 tons without a fatality and 30,826 tons with but one compensable accident. The ratio of the awards to Government lessees to the total in the United States is 1 to 6, with a production ratio of but 1 ton to 175. One strip mine, not mentioned, has produced about 7,000,000 tons without a fatality and comparatively few accidents involving lost time.

The first fatal accident in wagon mines on public land in the Billings district occurred this year, as compared with 7 to 10 annually in small mines in the district not under Government supervision. No fatal accidents have occurred on public lands in California, Montana, Nevada, Oregon, South Dakota, and Washington since the passage of the mineral-leasing act.

Observations were made of 21 coal fires on public lands during the year; 14 were old fires and 7 were new. Of the 14 old fires under observation 3 were underground and 11 were outcrop fires—6 in Wyoming, 2 in Montana, 2 in Utah, and 1 in Oregon. One of the outcrop fires that was dormant was reopened by a coal trespasser and is burning with renewed vigor. Of the 7 new fires inspected, 4 were stripping operations and 3 underground. Four fires, through prompt action, were successfully extinguished without damage. The fifth was believed to be extinguished but later rekindled; two are still under observation but are believed to be under control. Four of the fires started from burning Russian thistles and one from an accumulation of slack coal in a stripping mine operated in trespass.

Coal produced from leases, licenses, and permits on public lands, in tons, by fiscal years

State	1912-1925	1926-1930	1931	1932	1912-1932
Alaska.....	455,497.43	527,740.36	112,961.79	101,168.07	1,197,367.65
Alabama.....		322,926.00	121,002.00	81,630.00	525,558.00
California.....		104.00	250.00	72.00	426.00
Colorado.....	2,028,940.29	2,166,953.40	396,389.11	342,551.09	4,934,833.89
Idaho.....		1,533.30	986.52	3,228.70	5,048.52
Montana.....	252,973.58	1,304,063.74	114,929.27	192,432.47	1,864,389.06
Nevada.....		91.15	29.00		120.15
New Mexico.....	74,427.26	357,129.62	50,713.21	45,414.62	527,684.71
North Dakota.....	453,695.38	1,693,443.14	363,476.32	427,199.30	2,937,814.14
Oregon.....	688.97	8,798.66	755.50	1,369.43	11,612.56
South Dakota.....	1,842.63	2,772.82	489.29	2,152.95	7,257.69
Utah.....	487,303.62	2,117,190.17	830,187.56	767,553.37	4,202,234.72
Washington.....	164,280.14	88,508.08	25,461.74	44,190.25	322,440.45
Wyoming.....	4,465,885.23	5,137,978.53	1,035,557.77	871,485.64	11,510,907.17
	8,385,534.82	13,729,522.92	3,063,189.08	2,880,447.89	28,048,694.71

Phosphate.—Five phosphate leases were in effect during the year—2 in Idaho, 2 in Montana, and 1 in Nevada. Phosphate deposits of the West were developed primarily to dispose of sulphuric acid from copper smelters and to supply a postwar foreign fertilizer market, but now they are a source of fertilizer for sugar beets and wheat in the Rocky Mountain region of the United States and Canada.

Triple superphosphate is manufactured in Montana and Canada from the phosphate rock mined from Government leases in Idaho and from fee land in Montana. Government land in Montana is being developed, and the initial shipment is expected soon. Phosphate in the form of guano is mined in Nevada and shipped to California without treatment.

Phosphate, potassium, and sodium produced from public lands, in tons, by fiscal years

Mineral	1921-1925	1926-1930	1931	1932	Total
Phosphate:					
Idaho.....	6, 132.44	91, 505.02	68, 974.33	33, 058.88	199, 670.67
Nevada.....		45.45	80.72	40.25	166.42
	6, 132.44	91, 550.47	69, 055.05	33, 099.13	199, 827.09
Potassium: New Mexico.....		4, 726.94	45, 966.78		50, 693.72
Sodium:					
California.....	3, 145.30	73, 362.37	30, 226.00	32, 195.00	138, 928.67
Nevada.....	248.25	2, 546.08		700.00	3, 494.33
New Mexico.....			30.52		30.52
Oregon.....		* 80.00			80.00
	3, 393.55	75, 988.45	30, 256.52	32, 895.00	142, 533.52

* Produced in 1926-1928; not previously reported.

Potash.—At the end of the fiscal year 10 potash leases involving 22,266.78 acres and 155 permits involving 331,003.31 acres were in effect. One leasehold produced potash, 1 produced sodium salts, and on 2 experiments for recovery of potash were conducted.

During the year 45,967 tons of potash, an increase of about 872.4 per cent, was produced from public lands, from which \$22,327 accrued in rentals and royalties. During the year 19 test holes were drilled for potash in New Mexico to a total depth of 17,146 feet and 4 in Utah to a depth of 6,630 feet, a total of 23 to a total depth of 23,776 feet. Over 300 assays for potash were made at the wells in Utah.

For the development of potash in New Mexico 5.1 miles of standard railroad, 13.6 miles of narrow-gage railroad, and 18 miles of highway were built. A new headframe 110 feet high has been erected for skip hoisting, and a refinery for treating potash salts, which will make available any grade of muriate potash salts desired, is nearing completion.

The value of the output from the potash mine in New Mexico during the year is comparable to the amount of money spent by the Government during the last 20 years in its search for natural deposits of potash-bearing minerals in the United States. The New Mexico production and that from private lands in California will save to the industry in this country a large expenditure previously made in Europe. (For the production of potassium, see table above.)

Sodium.—In addition to 25 sodium permits covering 42,357.61 acres there were 2 sodium leases under supervision—1 in Nevada and 1 in Arizona. The Nevada lease is the source of a high-grade salt cake produced by leaching the sodium sulphate salts from the soil and evaporating the solution in solar ponds. The lease in Verde Valley, Ariz., is being further prospected. A mine on patented land, adjoining the leased land, has been in operation for several years. In prospecting for borax in the Kramer district, Calif., two wells were churn drilled to a total depth of 2,100 feet during the year. A total of 32,995 tons of soda ash, salt cake, borax, and sodium chloride, with a value of \$503,273, was produced from potash leases in California and New Mexico and from the sodium lease in Nevada. (For the production of sodium, see table above.)

Oil shale.—Of the two oil-shale leases so far issued one has been canceled and the other has been inactive.

Royalty, rentals, and bonuses.—Royalties, rentals, and bonuses accrued from mining operations on public land are shown in the following table:

Royalties, rentals, and bonuses accrued from mining operations on public lands by States for 1932 and by fiscal years in summary

	Coal	Sodium	Phosphate	Potash	Bonuses	Total
1932						
Alabama.....	\$3, 163. 00					\$3, 163. 00
Alaska.....	8, 225. 09					8, 225. 09
Arizona.....		\$203. 00				203. 00
California.....	15. 00			\$12, 968. 52		12, 983. 52
Colorado.....	49, 135. 90					49, 135. 90
Idaho.....	807. 19		\$4, 278. 93			5, 086. 12
Montana.....	22, 818. 85		670. 00		\$261. 00	23, 749. 85
Nevada.....			80. 00			80. 00
New Mexico.....	9, 447. 64			9, 358. 93		18, 806. 57
North Dakota.....	25, 235. 38					25, 235. 38
Oregon.....	3, 053. 86					3, 053. 86
South Dakota.....	373. 95					373. 95
Utah.....	125, 437. 02				5. 00	125, 442. 02
Washington.....	11, 047. 56	23. 05				11, 070. 61
Wyoming.....	112, 175. 78					112, 175. 78
	375, 939. 22	226. 05	5, 028. 93	22, 327. 45	266. 00	403, 787. 65
SUMMARY						
1912-1925.....	776, 069. 09	301. 07	1, 111. 38	24, 458. 65	148, 384. 00	950, 324. 19
1926-1930.....	1, 609, 049. 71	7, 200. 00	10, 534. 05	51, 776. 51	4, 495. 00	1, 683, 055. 27
1931.....	370, 350. 52	2, 261. 50	6, 634. 21	19, 760. 59	2, 074. 00	401, 080. 82
1932.....	375, 939. 22	226. 05	5, 028. 93	22, 327. 45	266. 00	408, 787. 65
	3, 131, 408. 54	9, 988. 62	23, 308. 57	118, 323. 20	156, 219. 00	3, 438, 247. 93

MINING OPERATIONS ON INDIAN LANDS

The greater part of the mining on Indian lands is in Oklahoma, where there are zinc and lead mines on restricted Quapaw land; coal mines on the segregated Choctaw and Chickasaw coal and asphalt lands and on restricted Indian lands; and scattered deposits of volcanic ash, building stone, gravel, lead, zinc, and other minerals of less value on other Indian lands. The Geological Survey functions as an agent for the Indian Service in the engineering phases of supervision over these operations.

Quapaw lead and zinc lands.—On the restricted Quapaw lead and zinc lands there are about 400 shafts, only 24 of which were used to hoist ore from 20 leaseholds for reduction in 13 mills during the past year. Only 3 mines of the 39 departmental leases in effect were operating at the end of the year. From the 39 leases 62 allottees and heirs received \$85,684.99 in royalties, in comparison with 50 allottees and heirs who received \$1,679,863.75 in royalties in 1926, the year of the greatest royalty returns.

The production in the calendar year 1931 represented 1.3 per cent of the lead and 5.3 per cent of the zinc produced in the United States. Continued efforts during the last several years have resulted in securing re-treatment of practically all of the re-treatable mill tailings on restricted land. The value of tailings re-treated since May, 1926, is \$4,569,677, and the royalty accruing to the Indians therefrom amounts to \$456,967.70. The value in mill tailings depreciates rapidly by oxidation and leaching, and early treatment conserves this value.

During the present depressed market more than usual effort was necessary to keep the idle shafts in repair to prevent caving and damage to surface and to mines and to protect the inhabitants of the community.

Segregated coal lands.—After 14 years of effort to sell the segregated Choctaw and Chickasaw coal lands there remains 890,739.48 acres unpatented. All the leases on these lands will have expired by September 25, 1962, and provisions have been made by Congress to re-lease the developed tracts to qualified applicants and to sell the remaining coal lands. Only 1 leased tract and 2 unleased tracts, containing 2,400 acres, were sold during the year; the sale price was \$86,760. To date 86,513.51 acres have been sold. The sale of 18,043.18 acres has been canceled, and 44,049.15 acres have been paid for and removed from supervision. With the extension of the use of natural gas and oil, the market for Oklahoma coals is much restricted, and further curtailment of sales and mining is to be expected. In addition to supervising the physical operations of leased tracts, the operations on lands sold but not patented are carefully watched to see that the deposits are not destroyed should the tract revert to the owners. The cancellation of 30 coal leases, cases of trespass, coal fires, and sales of land occupied much of the engineer's attention. Of the 12 mines effectively rock dusted in Oklahoma, 7 are on segregated Indian coal land, and of the 13 mines in which some rock dusting has been done, 10 are on segregated land.

Since 1926, when it became mandatory to furnish projected plans for approval before opening new mines, 18 mines have departed from the old systems and are meeting success with new methods. Electric cap lamps have been installed in all except eight mines on segregated lands at which no electric current is available. A large part of the segregated land has been remapped geologically. Of particular importance was the recent correlation of beds and the relocation of the outcrop lines which were mapped nearly 30 years ago. Further geologic work is needed.

Restricted Indian lands.—On restricted allotted Cherokee, Choctaw, and Creek Indian lands there are 57 coal leases, 2 volcanic-ash leases, and 1 lead-zinc lease. On these lands 14 mines were in operation, producing 48,763.00 tons of coal with a royalty, rental, and bonus value of \$8,074.12.

Agency coal mines.—In Arizona, Colorado, New Mexico, and Utah the cost of coal has been reduced at several coal mines operated by the Indian Service by adopting improved mining methods, locating sites and deposits where the coal could be more economically mined, and encouraging at some plants the use of mine-run coal and at others the use of more of the smaller sizes of coal which were formerly wasted. Several coal samples were taken, 33 coal mines operated for agency coal were examined, and 15 maps were made from surveys.

Miscellaneous Indian mining leases.—In California reports were made for the Indian Service on 2 mining-lease applications, and in Arizona a large area containing asbestos was mapped in cooperation with the topographic branch and 21 asbestos mines were examined. A report was published on another area containing a large deposit of iron ore.

OIL AND GAS OPERATIONS ON PUBLIC LAND

General features.—Engineering and geologic details were completed and departmental approval obtained for the cooperative or unit plans of development of the Big Sand Draw and Billy Creek gas fields, Wyoming, pursuant to the act approved March 4, 1931 (46 Stat. 1523), amending the general leasing law of February 25, 1920.

The department has cooperated with lessees and permittees by relieving them from unnecessary financial burdens through extending permits, granting relief from the drilling and producing requirements under leases, and allowing suspended preference rights to lands not required by law to be leased, all subject to conditions that fully protect the public interest. One of the relief measures provides that permittees or lessees, in lieu of drilling necessary offset wells to protect the property from drainage of oil or gas, may pay a sum estimated to reimburse the United States for current loss of royalty through drainage. This provision has obviated the necessity

for expenditures of large sums for drilling wells from which but small revenue might be obtained because of present overproduction and consequent limited market. During the fiscal year approximately \$10,000 accrued as compensatory royalty because of drainage of oil and gas from public land.

Investigations were made in California and Wyoming relative to the establishment of minimum field prices for crude oil, natural gas, and natural-gas gasoline from public land, and reports were submitted to the department.

Permits and leases.—During the fiscal year 1,112 prospecting permits for oil and gas were canceled and 12 leases were relinquished or canceled, as compared with a total cancellation of 1,565 permits and leases during 1931.

Oil and gas leases and permits on the public domain

State	Issued during fiscal year 1932				Under supervision of Geological Survey June 30, 1932					
	Leases		Permits		Leases		Permits		Suspended preference rights to leases	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Alaska.....			8	17,082.03			142	408,189.13		
Arizona.....							91	214,399.23		
Arkansas.....							15	23,502.60		
California.....	3	1,280.00	3	559.82	193	51,698.87	427	345,234.87	4	2,103.10
Colorado.....	3	1,817.64	5	2,715.01	24	18,312.77	400	563,713.35	2	3,712.21
Idaho.....			4	3,633.21			65	126,380.71		
Kansas.....							1	155.32		
Louisiana.....					10	770.82	1	40.00		
Montana.....	3	674.68	7	10,006.51	76	15,858.94	478	569,942.77	1	1,358.82
Nevada.....							49	114,758.37		
New Mexico.....	22	11,454.32	1	3,520.20	63	43,407.31	807	1,960,741.78	17	26,865.84
North Dakota.....			4	3,239.91			18	24,131.16		
Oklahoma.....					17	730.20	5	1,682.00		
Oregon.....			1	880.11			15	31,679.46		
South Dakota.....							15	16,123.76		
Utah.....	1	200.00	3	3,153.68	12	4,700.74	522	955,225.31	2	3,720.00
Wyoming.....	20	12,284.62	5	11,012.73	397	121,461.42	845	1,768,543.42	8	11,023.53
	52	27,711.26	41	55,803.21	792	256,941.07	3,986	7,119,443.24	34	48,783.50

Wells.—On June 30, 1932, there were under supervision on public land a total of 6,595 wells, of which 3,593 were capable of producing oil or gas.

The effect of continued overproduction and the liberal conservation and cooperative policies of the department are reflected in the continued decrease in the number of wells completed to production and the increase in the number of wells shut in on public land in the major oil-producing public-land States. Completions decreased from 146 during the calendar year 1930 to 50 during 1931, or 65.7 per cent, and from 30 during the first six months of 1931 to 16 during the corresponding period in 1932, or approximately 46.7 per cent; wells shut in increased from 699 on July 1, 1931, to 841 on July 1, 1932, or approximately 20.3 per cent.

New wells and wells shut in in major oil-producing public-land States

State	Wells completed to production on public lands				Wells completed to production on all lands			
	1929	1930	1931	Jan. 1-July 1, 1932	1929	1930	1931	Jan. 1-July 1, 1932
California.....	63	32	7	2	874	752	230	89
Colorado.....	4	6	2	0	35	14	15	1
Montana.....	24	19	9	2	292	125	80	16
New Mexico.....	27	24	8	4	42	169	31	13
Utah.....	0	4	3	1	9	13	5	1
Wyoming.....	91	61	21	7	134	115	55	17
	209	146	50	16	1,386	1,188	416	142

State	Wells shut in on public lands				Wells shut in on all lands			
	Mar. 12, 1929	July 1, 1930	July 1, 1931	July 1, 1932	Mar. 12, 1929	July 1, 1930	July 1, 1931	July 1, 1932
California.....	270	311	339	302	3,560	5,431	7,180	6,741
Colorado.....	4	2	6	8	8	9	15	23
Montana.....	22	40	43	42	96	189	191	181
New Mexico.....	5	33	39	21	17	70	124	89
Utah.....	6	9	13	16	15	24	30	26
Wyoming.....	159	204	259	453	417	465	549	538
	466	599	699	841	4,112	6,188	8,089	7,904

Production.—Production of oil and gas from public lands during the fiscal year compared with production during 1931 as follows: Crude oil increased 2,633,106 barrels, or 11.1 per cent; natural gas increased 8,914,632,000 cubic feet, or 21.2 per cent; natural-gas gasoline decreased 13,561,770 gallons, or 12.2 per cent. In the following tables the figures for 1930 are included in the 5-year total for 1926-1930 and are also shown separately for comparison with 1931 and 1932.

Petroleum, natural gas, and natural-gas gasoline produced from public lands
 1932, by States

	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)
California.....	14,237,495.65	24,390,649.00	55,896,426.09
Colorado.....	544,073.02	* 1,308,602.00	13,982.00
Louisiana.....	2,983.99	982,216.00	34,056.35
Montana.....	375,567.00	1,639,101.00	.....
New Mexico.....	1,683,880.30	7,749,785.00	1,197,121.00
Oklahoma.....	185,899.57	.....	69,399.31
Utah.....	6,695.11	* 44,949.00	.....
Wyoming.....	9,417,621.87	14,752,514.00	40,726,822.00
	26,454,217.11	50,876,816.00	97,937,827.39

Total			
1921-1925.....	118,333,954.01	60,298,796.00	63,997,718.07
1926-1930.....	128,609,878.94	117,075,823.64	264,503,694.35
1930.....	(27,419,509.35)	(39,124,116.00)	(101,470,391.39)
1931.....	23,821,111.33	41,862,184.00	111,499,898.39
1932.....	26,454,217.11	50,876,816.00	97,937,827.39
	297,219,161.39	270,213,622.64	537,938,909.94

* Includes under natural gas 742,000 cubic feet of carbon dioxide gas.

* Includes under natural gas 34,059,000 cubic feet of carbon dioxide gas.

Royalties and bonuses.—Royalties accrued from oil and gas operations on public lands during the fiscal year compared with royalties accrued during 1931 as follows: Crude oil decreased \$62,837, or 2.4 per cent; natural gas increased \$117,913, or 66.6 per cent; natural-gas gasoline increased \$39,211, or 20.6 per cent; a total net increase of \$94,287, or 3.2 per cent.

In the following table figures for 1930 are included in the 5-year total for 1926-1930 and also shown separately for comparison with 1931 and 1932.

Royalty and bonuses accrued from oil and gas operations on public lands

1932, by States

	Petroleum	Natural gas	Gasoline	Bonuses	Total
California.....	\$1,274,060.14	\$190,791.11	\$134,260.99	-----	\$1,599,112.24
Colorado.....	20,968.98	4,225.46	10.48	-----	25,204.92
Louisiana.....	282.33	3,478.91	59.29	-----	3,820.53
Montana.....	32,120.43	7,241.31	-----	\$88.00	39,449.74
New Mexico.....	48,815.04	20,198.54	895.78	757.00	70,666.36
Oklahoma.....	17,504.44	-----	103.76	-----	17,608.20
Utah.....	468.02	245.13	-----	120.00	833.15
Wyoming.....	1,110,971.15	68,819.48	93,973.21	67,223.89	1,340,987.73
	2,505,190.53	294,999.94	229,303.51	68,188.89	3,007,682.87
Total					
1921-1925.....	\$32,938,494.47	\$398,543.30	\$251,197.70	\$2,768,065.14	\$36,356,320.61
1926-1930.....	24,460,387.20	591,767.49	714,943.75	935,722.21	26,702,820.65
1930.....	(3,809,947.58)	(172,878.79)	(164,181.04)	(1,600.20)	(4,148,607.61)
1931.....	2,568,027.70	177,067.05	190,092.48	271,108.14	3,206,315.37
1932.....	2,505,190.53	294,999.94	229,303.51	68,188.89	3,007,682.87
	62,472,099.90	1,462,397.78	1,385,537.44	4,043,104.38	69,363,139.50

OIL AND GAS OPERATIONS ON NAVAL PETROLEUM RESERVES

Leases and wells on naval petroleum reserves June 30, 1932

State	Leases		Wells		
	Number	Acres	Productive		Total
			Active	Shut in	
California:					
Reserve No. 1.....	5	1,090.32	51	43	134
Reserve No. 2.....	20	9,518.65	177	184	470
Wyoming:					
Reserve No. 3.....				74	87
	25	10,608.97	228	301	691

Production from Naval Petroleum Reserve No. 3, in Wyoming, was suspended December 31, 1927, and the total royalty accrued from 1923 to the date of suspension amounted to \$848,947.91. Supervision on this reserve is confined at present to periodic observation of well pressures, well repairs from time to time, and advice to the Navy Department.

Royalties accrued during the fiscal year from Naval Petroleum Reserves Nos. 1 and 2, in California, as follows: Petroleum, \$581,857; natural gas, \$37,868; natural-gas gasoline, \$70,463. The total royalties accruing from the three reserves for the fiscal years 1921 to 1932 amount to \$25,856,989.

Petroleum, natural gas, and gasoline produced from naval reserves

	Fiscal year	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)
California.....	1921-1925	37,882,945.09	35,544,349.81	24,508,751.07
	1926-1930	48,389,149.93	48,852,746.46	19,177,197.2
	1930	(6,978,922.16)	(6,817,458.00)	(25,567,896.00)
	1931	5,590,418.46	5,123,456.00	22,748,065.00
	1932	3,919,625.61	4,442,014.00	18,539,144.00
Wyoming.....	1923-1928	96,782,139.09	93,962,566.27	194,973,757.00
		3,550,227.63	5,162,869.00	2,483,896.00
Total.....	1921-1932	100,332,366.72	99,125,435.27	197,457,653.00

OIL AND GAS OPERATIONS ON INDIAN LAND

Cooperation with the Indian Service was continued in Oklahoma through inspection and supervision of oil and gas operations and royalty accounting for all Indian lands in the State except those of the Five Civilized Tribes and the Osage Reservation. In the area owned by the Five Civilized Tribes the Geological Survey acts only in a cooperative or consulting capacity, and in the Osage Reservation its activities are limited to response to requests by the superintendent for specific information or special reports of investigations.

Under a cooperative agreement approved by the department November 12, 1931, the Geological Survey assumed direct technical supervision of all oil and gas operations on Indian lands in the Rocky Mountain States, and on January 1, 1932, it undertook the accounting for royalties from production of oil, gas, and gasoline from Indian lands in those States.

Through careful supervision of royalty accounting, irregular practices by lessees in Oklahoma in submitting royalty statements, resulting in loss of revenue to the Indians, were discontinued. In Oklahoma the Geological Survey witnessed 526 oil runs and 62 physical tests on casing-head gas, assessed more than \$15,600 as back royalty due to the Indians in 4 cases as a result of correcting oil-gravity calculation, appraised 435 Indian allotments prior to sale of leases and reported as to the adequacy of bonuses offered, made royalty appraisals on 38 tracts of land, and made 4,310 field investigations of well operations, wastage, pollution, and general lease conditions and submitted reports thereon to the superintendents.

Oil and gas leases and wells on Indian reservations under supervision of the Geological Survey June 30, 1932

State, reservation, and land designation	Leases			Wells		Total royalty and rentals, fiscal year 1932
	Nonproductive	Productive	Total	Productive	Being drilled	
Arizona:						
Navajo Executive order.....	14		14			
Colorado:						
Ute tribal.....		1	1	11		
Ceded Ute.....	4	1	5	14	1	
	4	2	6	25	1	
Montana:						
Blackfeet allotted.....	37		37		1	
Blackfoot tribal.....	1		1			
Crow allotted.....	95	2	97	3		
Crow tribal.....	6	1	7	2		
	139	3	142	5	1	
New Mexico:						
Navajo allotted.....	18		18	7		
Navajo tribal.....		3	3	28	4	
Navajo Executive order.....	9		9	1		
Ute tribal.....		2	2	3		
	27	5	32	39	4	
Oklahoma:						
Five Civilized Tribes Agency—						
Cherokee allotted.....	3,308	323	4,367	4,684	9	\$1,455,004.15
Choctaw allotted.....		61				
Creek allotted.....		504				
Chickasaw allotted.....		20				
Seminole allotted.....		150				
Seminole tribal.....		1				
Kiowa Agency—						
Kiowa allotted.....	125		125			124,184.72
Comanche allotted.....	83	12	95	22		
Apache allotted.....	17	6	23	18		
Wichita allotted.....	252		252			
Caddo allotted.....	195		195			
Pawnee Agency—						
Ponca allotted.....	44	11	55	50		96,955.74
Ponca tribal.....		1	1	1		
Otoe allotted.....	97	2	99	2		
Tonkawa allotted.....	7		7			
Pawnee allotted.....	85	20	105	61		
Pawnee tribal.....	3		3			
Kaw allotted.....	11	3	14	32		
Shawnee Agency—						
Iowa allotted.....	27		27			160,770.60
Kickapoo allotted.....	54		54			
Pottawatomie allotted.....	28	10	38	31	1	
Sac and Fox allotted.....	82	8	90	22		
Sac and Fox tribal.....		1	1	3		
Shawnee allotted.....	137		137			
Cheyenne and Arapahoe Agency allotted.....	199		199			29,016.62
	4,754	1,133	5,887	4,926	10	1,805,931.83
Utah: Navajo Executive order.....	6		6			
Wyoming:						
Shoshone allotted.....	4	6	10	41		
Shoshone tribal.....	1	1	2	5		
Shoshone ceded.....	28		28	34		
	33	7	40	80		
Grand total.....	4,977	1,150	6,127	5,075	16	

WORK ON PUBLICATIONS

TEXTS

BERNARD H. LANE, Editor

During the year 22,332 pages of manuscript were edited and prepared for printing by the section of texts, and 3,904 galley proofs and 9,634 page proofs were read and corrected. This work included the editing and some of the proofreading of 29 guidebooks for the excursions of the Sixteenth International Geological Congress, to be held in the United States in 1933. Indexes were prepared for 42 publications, covering 6,373 pages. Copy and proof or stencils for 2,052 pages of multigraph and mimeograph matter were read. The publications issued during the year are listed on pages 1-3. The total number of pages in the new book publications was 11,238. In addition to the publications in the regular series 71 brief papers, some of them accompanied by maps, were issued in mimeographed form as memoranda for the press.

At the end of the year five persons were employed in this section.

The editor continued to serve as a member of the department subcommittee to assist in the revision of the Style Manual of the Government Printing Office. The subcommittee has submitted its report to the Public Printer, whose style board is now studying it.

ILLUSTRATIONS

C. A. WECKERLY, Chief Illustrator

The number of drawings and photographs prepared by the section of illustrations was 2,156, including 312 maps, 354 sections and diagrams, 18 plates of sections, 18 charts and plans, 439 photographs, and 1,015 paleontologic drawings; 217 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany 60 reports numbered 1,499, to be reproduced by chromolithography, photolithography, halftone, and zinc etching. The number of proofs received and examined was 1,673. At the end of the year material for illustrating 32 reports was in hand. The section consists of nine employees. During the year two additional draftsmen were loaned by the geologic branch and one for part time by the water-resources branch.

GEOLOGIC EDITING AND DRAFTING OF MAPS AND ILLUSTRATIONS

GEORGE W. STOSE, Editor of Geologic Maps

The compilation and drafting of the geologic map of the United States on the scale of 1:2,500,000 was completed, and 90 per cent of the boundaries and letter symbols were engraved. The north-east quarter of the map was transferred to stone, and 75 per cent of the color stones were prepared. The southeast quarter, carrying the title and explanation, was transferred to stone, and color-stone sheets were prepared. The west half was nearly ready for transfer to stone.

The compilation and drafting of the geologic map of California on the scale of 1:500,000 was completed and the map sent to the California Division of Mines for correction, further compilation, and addition before publication. The geologic map of Minnesota was

edited in this section and printed under the supervision of the section for the State geological survey. Two-color proofs of the geologic map of Pennsylvania, which was compiled in this section for the State topographic and geologic survey, were read by the section and approved for printing. The geologic map of West Virginia, compiled in this section and being published by the State geological and economic survey, reached color proof. The preliminary geologic map of Texas was photolithographed and copies distributed for criticism. The geologic map of Colorado, compiled in cooperation with the State, was received for editing and preparation for publication. Compilation of the geologic map of Montana in cooperation with the State bureau of mines and geology was begun. A preliminary geologic map of Nevada was compiled in cooperation with the State bureau of mines.

Folio 222 (Gaffney-Kings Mountain, S. C.-N. C.) was published. The maps and text of Folio 223 (Coatesville-West Chester, Pa.) were printed. The color proofs of the maps of Folio 224 (Somerset-Windber, Pa.) were approved for printing. The maps of Folio 226 (Montevallo-Columbiana, Ala.) reached stone proof.

Illustrations for 54 reports were examined and edited and in part drawn for the section of illustrations, and 30 illustrations for 12 reports by geologists were drawn.

The oil and gas map of the United States was completed and published.

INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

W. M. BEAMAN, Chief

During the year 112 new topographic maps were edited and transmitted for engraving, 259 published topographic maps, 10 State maps, and 5 State index circulars were edited for reprint, and 303 maps were edited as illustrations for Geological Survey reports—a total of 689 maps edited. First, second, combined, and woodland proofs of engraving for new topographic maps and reprints numbering 598 and proofs of maps reproduced by photolithography in one to three colors numbering 238 were read. At the end of the year 170 new topographic maps were in progress of engraving and printing and 200 new topographic maps were in preparation for submission for reproduction. The topographic maps published during the year are listed on pages 3-6.

DISTRIBUTION

R. C. SHELSE, Chief

A total of 601 publications, comprising 81 new books and pamphlets, 141 new or revised topographic and other maps, 1 geologic folio, and 378 reprinted topographic and other maps, were received by the division of distribution during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 164,174 books and pamphlets, 3,552 geologic folios, and 1,496,165 topographic and other maps, a grand total of 1,663,891, or more than twice as many as in 1931.

The division distributed 182,059 books and pamphlets, 4,649 geologic folios, and 706,730 maps, a grand total of 893,438, of which 3,877 folios and 547,746 maps were sold. Compared with 1931 these

figures show increases of about 65,000 books and pamphlets and nearly 400 geologic folios but a decrease of about 100,000 maps. The sum received for publications and deposited in the Treasury was \$34,737.32, including \$33,948.36 for topographic and geologic maps and \$788.96 for geologic folios. In addition \$1,733.90 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$36,471.22.

The division received and answered 46,947 letters.

At the end of the year the division included 15 employees.

ENGRAVING AND PRINTING

S. J. KUBEL, Chief Engraver

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the fiscal year 187 newly engraved topographic maps were printed, including 11 revised maps. The division also engraved and printed the sheet of standard symbols and the United States base map, scale 1:2,500,000. Two new maps were photolithographed and printed, making a total of 141 new maps printed and delivered. Corrections were engraved on the plates of 253 maps. Reprint editions of 375 engraved topographic maps and 3 photolithographed State and other maps were printed and delivered. In addition, 43 new topographic maps had been engraved and were in press June 30, and the engraving of 16 other new topographic maps was nearly completed. Of new and reprinted maps, 519 different editions, amounting to 1,489,975 copies, were delivered. One new geologic folio was printed, its edition amounting to 3,552 copies. Extra geologic folio sheets numbering 2,750 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for 43 other units of the Government and 6 State governments, including many reprints, and the charges for it amounted to about \$142,000, for which the appropriation for engraving and printing geologic and topographic maps was reimbursed.

Transfer impressions numbering 288 were made during the year, including 190 furnished to contracting lithographic printers on requisition of the Government Printing Office, 11 furnished to other branches of the Government, 10 furnished to State surveys, and 77 furnished to private firms. The amount turned over to miscellaneous receipts from this source was \$195.67.

Of contract and miscellaneous work of all kinds, 2,570,089 copies were printed. Including topographic maps, a grand total of 4,060,064 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 18,128 negatives (5,616 wet (of which 4,601 were for photolithographs), 149 paper, 1,915 dry, 9,278 field negatives, and 1,177 lantern slides), 33,946 prints (4,943 maps and diagrams and 29,003 photographs for illustrations), 3,678 zinc plates, 307 zinc etchings, 42 celluloid prints, 152 lantern slides colored, 2 transparencies colored, 2 prints colored, and 5,274 prints mounted.

ADMINISTRATION*JULIAN D. SEARS, Administrative Geologist**JOHN J. MADIGAN, Chief Clerk*

The administrative geologist assists the director in all phases of general administration, performs special tasks assigned to him by the director from time to time, serves as acting director in the director's absence, and has special supervision over the section of illustrations.

The chief clerk, in addition to performing the duties usually pertaining to that office, serves as budget officer and exercises administrative supervision over the division of engraving and printing, the division of distribution, the section of correspondence and records, the section of accounts, the library, and the division of field equipment.

CORRESPONDENCE AND RECORDS*C. A. KING, Chief*

The work of the section of correspondence and records was of the same general character as during the fiscal year 1931.

Mails, files, and records.—During the year 100,052 pieces of mail, of which 2,366 were registered, were opened and referred. In addition 158,456 letters were received direct by the other units, making a total of 258,508, an increase of 5 per cent compared with 1931. Of the letters opened in this section 18,235 contained \$35,052.36 remitted for Geological Survey publications. The number of ordinary letters mailed through the section was 56,899; of registered letters and packages, 1,099. In addition, 146,944 pieces of mail were sent out direct from other units. The total number of outgoing pieces of mail for the Geological Survey was 204,942.

Freight and express.—During the year 2,920 pieces of freight and express were handled, 1,664 outgoing and 1,256 incoming.

Personnel.—The roll of secretary's appointees numbered 1,117 at the end of the fiscal year, 10 less than at the end of the fiscal year 1931. The total number of changes in personnel was 316, including 81 appointments, 91 separations, and 204 miscellaneous changes.

During the calendar year 1931, 22,470 days of annual leave and 4,467 days of sick leave were granted, being 72 per cent of the amount of annual leave that could have been taken and 14 per cent of the sick leave that it would have been possible to grant. In addition, 7,836 days of leave without pay and furloughs were granted.

ACCOUNTS*C. K. FRANCIS, Chief*

During the year 16,876 Federal field accounts, 2,733 State field accounts, 734 special disbursing agent accounts, 1,461 transportation bills, and 224 telegraph bills were audited and transmitted for payment. In the audit of these accounts 857 suspensions and disallowances were made. The section received 336 printing and binding requisitions, 1,062 stationery requisitions, 3,338 miscellaneous supply requisitions, 2,228 letters of employment, and 355 contracts.

Condensed statements covering expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

Amounts appropriated for, transferred to, and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1932

	Funds available			Total	Expenditures		Balance	
	Amount of appropriation	Repayments on account of work performed			Disbursements	Outstanding liabilities		Total
		Made	To be made					
APPROPRIATIONS								
Salaries.....	\$150,000.00	\$290.00		\$150,290.00	\$150,045.48	\$218.33	\$150,263.81	
Topographic surveys.....	780,000.00	318,764.42	\$20,575.33	1,119,339.75	905,414.07	24,142.32	929,556.39	
Geologic surveys.....	400,000.00	20,449.99	4,716.09	434,166.08	426,113.93	7,662.17	433,776.10	
Fundamental research in geologic science.....	100,000.00	249.35		100,249.35	96,916.77	2,723.82	99,640.59	
Volcanologic surveys.....	35,000.00			35,000.00	30,966.79	3,245.70	34,215.49	
Alaskan mineral resources.....	84,500.00	238.98		84,738.98	72,800.05	11,783.10	84,673.15	
Gaging streams.....	720,000.00	283,611.49	64,923.87	1,068,535.36	1,030,271.18	25,254.46	1,055,525.64	
Classification of lands.....	190,000.00	898.90		190,898.90	195,745.24	4,096.71	190,841.95	
Printing and binding.....	190,000.00	1,086.77	150.66	191,237.43	65,621.88	125,615.85	191,237.43	
Preparation of illustrations.....	23,240.00	212.91		23,452.91	23,399.92	40.25	23,440.17	
Geologic and topographic maps.....	190,000.00	110,434.80	24,897.09	325,331.89	308,437.97	16,190.36	324,628.33	
Mineral leasing.....	270,000.00	739.44	186.91	270,926.35	262,811.86	7,144.11	269,955.97	
	3,141,740.00	\$745,977.05	\$115,449.95	4,003,167.00	3,568,635.14	228,119.88	3,796,756.02	
TRANSFERS								
Alaska Railroad appropriated fund (act Feb. 14, 1931).....	71,300.00	732.78	3.89	72,036.67	54,819.23	1,701.97	56,521.20	
Engineer operations in the field (War Department, act Feb. 14, 1931), 1931-Dec. 31, 1932.....	4,500.00			4,500.00	3,346.32	129.72	3,476.04	
Federal jails, buildings, and equipment (Justice Department, act Feb. 14, 1931).....	828.32			828.32	828.32		828.32	
Federal Power Commission (act Feb. 14, 1931), 1932.....	4,200.00	23.40		4,223.40	3,172.42	468.32	3,640.74	
Flood control, Mississippi River and tributaries (War Department, act Feb. 14, 1931).....	264,361.00	405.73		264,766.73	204,060.53	2,560.91	206,651.44	
Fredericksburg and Spotsylvania County Battlefield Memorial, Virginia (War Department, act Feb. 14, 1931), 1931-32.....	1,155.43			1,155.43	1,073.06	82.37	1,155.43	
George Washington Bicentennial Commission (act May 21, 1929).....	2,900.00			2,900.00	2,727.69	110.53	2,888.22	
Helium investigations, Bureau of Mines (Commerce Department, act Feb. 14, 1931), 1932.....	950.07			950.07	950.07		950.07	
Irrigation, Indian reservations (reimbursable, act Feb. 14, 1931), 1931-32.....	5,490.00			5,490.00	5,243.75	223.69	5,467.44	
Irrigation, San Carlos and Florence-Casa Grande projects, Arizona (reimbursable, act Feb. 14, 1931), 1931-32.....	4,013.00			4,013.00	3,744.77	268.23	4,013.00	
Maintenance and improvement of existing river and harbor works (War Department, act Feb. 14, 1931).....	83,028.29	202.60	173.16	84,314.05	72,231.36	790.45	73,022.81	
At close of the United States (act May 21, 1929), 1932.....	12,166.00			12,166.00	6,966.66	5,206.00	12,166.00	
							\$15,515.47	
							\$1,023.96	
							582.06	
							\$58,115.29	
							\$1,155.43	
							\$61.78	
							950.07	
							5,467.44	
							4,013.00	
							73,022.81	
							12,166.00	
							\$11,262.24	
							

Military surveys and maps (War Department, act Feb. 14, 1931), 1930-Dec. 31, 1931.....	341.63	341.63	341.63	341.63	341.63	.00
National Park Service (act Feb. 14, 1931), 1931-32.....	3,022.28	3,022.28	3,022.28	3,022.28	3,022.28	.00
Operation and conservation of naval petroleum reserves (Navy Department, act Feb. 14, 1931), 1932.....	50,000.00	50,000.00	49,471.28	528.70	49,999.98	3.02
Supervising mining operations on leased Indian lands (act Feb. 14, 1931), 1932.....	95,000.00	95,000.00	93,467.66	1,538.25	94,204.32	1,263.34
Waterways treaty, United States and Great Britain (State Department, act Feb. 28, 1931), 1932.....	57,900.00	630.23	58,673.48	1,418.52	58,673.48	.00
Grand total.....	3,803,806.02	747,972.79	4,668,015.72	242,974.54	4,373,723.42	294,292.30

* In addition to these appropriations, there was an allotment of \$12,573.23 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

* Included in this balance is \$150,000 which is continued available for expenditure in the fiscal year 1933.

* Included in this balance is \$9,000 over appropriated.

* Included in these amounts is \$63,032.62 covering work performed by Geological Survey units for other Geological Survey units, necessarily reported in combining totals but otherwise a duplication.

* These balances continue available for expenditure in the fiscal year 1933.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1932

Object and expenditure	Geological Survey salaries	Topographic surveys	Geologic surveys	Fundamental research	Volcanologic surveys	Alaskan mineral resources	Gaging streams	Classification of lands	Printing and binding	Preparation of illustrations	Geologic and topographic maps of the United States	Mineral leasing	Total
Personal services	\$150,263.81	\$804,851.42	\$373,627.68	\$87,243.43	\$25,511.33	\$95,944.29	\$810,517.86	\$164,905.59		\$32,141.27	\$291,207.20	\$324,146.65	\$100,380.53
Stationery and office supplies	3,285.15	1,512.85	1,512.85	29.85	164.10	263.43	11,478.64	247.06		103.67	33,801.17	3,060.16	54,016.06
Scientific and educational supplies		609.49	2,254.52	102.02	82.44	2.94	977.17	90.77		8.41	10.41	355.56	4,493.73
Sundry supplies		3,305.29	1,099.10	59.83	783.18	877.73	6,397.13	257.90			7,763.00	744.59	21,276.85
Subsistence and care of animals and storage and care of vehicles		1,263.73	593.51				20.73	188.55					2,066.52
Telephone service		551.26	172.36	.45	2.25	108.51	998.81	46.33			3.47	494.61	2,380.05
Telephone service		237.39	176.91	4.80	60.35	20.75	2,293.58	95.17				2,463.06	5,332.06
Other communication service		25.82	14.45		1.65		40.55					84.25	165.72
Travel expenses		107,967.75	23,330.90	6,032.15	2,529.87	25,804.78	92,465.38	17,236.30		1.50	156.29	23,076.01	298,623.93
Attendance at meetings		156.17	1,368.34			103.48	774.92					728.43	3,131.34
Hire, maintenance, operation, repair of horse-drawn and motor-propelled passenger-carrying vehicles		1,914.14	3,408.11	713.48	398.51	499.61	32,687.08	4,631.88				22,106.65	66,447.16
Transportation of things		49,402.75	6,645.08	762.27	632.47	5,256.34	27,260.72	3,281.91			86.83	3,065.71	96,244.08
Printing and binding													191,237.43
Lithographing, engraving, and etching		13,713.31	570.94	29.50			596.04	1,729.24		21.25		42.41	16,702.69
Stenographic work, typewriting, and duplicating work, etc. (job work)		6.00	27.55				17.49					6.00	57.04
Photographing and making photographs and prints		40,128.98	3,192.03	2,088.69	191.88	859.35	3,268.87	2,186.85		54.80	12,322.30	436.70	64,730.45
Heat, light, power, water, and electricity			77.69		58.31	40.16	363.50					4,098.62	4,638.28
Rents		824.04	201.03	12.00	40.00	51.62	6,508.06					7,965.64	15,602.99
Repairs and alterations		4,190.67	241.32	7.77	133.76	55.65	3,142.53	9.65		2.44	7,245.78	2,149.12	17,178.69
Special and miscellaneous current expenses		34.80	84.31			429.73	148.69	6.96				625.98	1,280.47
Purchases of passenger-carrying vehicles		1,632.11	431.55		1,020.80		21,878.07	1,946.00				12,751.38	39,600.00
Furniture, furnishings, and fixtures		499.04	190.07		218.65	631.14	970.46	82.80			197.13	1,088.89	3,878.18
Educational and scientific equipment		12,884.90	10,694.19	836.34		1,261.62	70,046.42	735.40		4.84	7,422.20	2,570.71	106,842.90

Structures.....	14,811.80	1,389.08	515.53	75.28	1,308.77	11,194.72	21.45	35,062.56	424.76	513.70
Miscellaneous transfers and adjustments.....	34,097.33	3,464.60	1,202.38	1,659.49	1,308.77	40,781.31	41.99	331.38	67,861.95	67,861.95
	150,263.81	1,099,473.33	434,728.17	99,640.59	34,215.49	141,194.35	201,035.82	4,201.33	1,779.39	42,762.18
								41.99	1,779.39	145,162.50
								339,791.06	414,157.27	4,373,723.42

In addition to the above amounts, there was expended directly by cooperating agencies \$108,701.29 in connection with cooperative topographic surveys and \$338,370.49 in connection with cooperative stream gaging.

LIBRARY

GUY E. MITCHELL, *Librarian*

The two main regular items of expenditure in the library, aside from the salaries, cover the purchase of new books and the binding of old books and accumulated parts. More money was available for both these items in 1932 than ever before—\$3,000 for new books and \$7,500 for binding—and in consequence the library shelves present a much better appearance. Besides the 3,100 books bound at the Government Printing Office, 369 books were bound in the library in serviceable fashion. About 20,000 books bound wholly or partly in leather were treated with petrolatum, which experiments made in the chemical laboratory had shown to be a safe and satisfactory leather preservative.

The cooperative project of inventorying the location, throughout the United States and Canada, of all files of serial publications issued by foreign governments was completed.

The accessions during the year comprised 13,193 books, pamphlets, and periodicals and 1,136 maps. The readers and users of books and maps in the library numbered 7,614, of whom 2,111 were not members of the Geological Survey. The loans for use outside the library included 6,267 books and 299 maps. In the work of cataloging 4,988 cards were added to the catalogue, 1,028 catalogue cards were revised, 358 titles were sent to the Library of Congress for printing, and 101 galley proofs were read. The books collated and sent to the bindery numbered 3,100, and 2,992 newly bound books were recorded and labeled. Translations of 67 communications were made for other divisions of the Geological Survey.

Work on the bibliography of North American geology for 1931 and 1932 was about 60 per cent completed at the end of the year.

The division of engraving and printing and the division of field equipment have rendered special assistance during the year.

The service rendered by the library, stated in terms of the number of users of library material and books and maps shipped on loan, was 39 per cent to the Geological Survey and 61 per cent outside. The usefulness of this unique collection is appreciated more and more each year.

DIVISION OF FIELD EQUIPMENT

R. L. ATKINSON, *Chief*

In the instrument shop special attention has been given to the design and construction of instruments to facilitate the work of the engineers in the several branches, including discharge integrators, improvements in current meters, a deep-well measuring apparatus, stainless-steel connector and weight hangers, a tag-line reel, a depth recorder for reels, a collimator for adjusting instruments, and a bracket so designed that clocks and gear ratio on recorders can be readily changed. Numerous other pieces of equipment were made, many of them of stainless steel. The shop repaired and rebuilt more than 2,200 instruments of different kinds and did work for several Government units outside of the Geological Survey.

The cabinet shop made 6 discharge-integrator cases and shipping boxes, 42 special current-meter boxes, a special well-core case, an equipment case and a focusing frame for large camera, and several other special pieces, besides the routine cabinet work.

The electrical shop made monthly inspection and repairs of 82 motors and did work for the Geological Survey laboratories on other electrical appliances.

The clerical force filled 2,571 requisitions for instruments, issued 18,625 pieces of equipment, mailed 2,586 packages, shipped 1,664 pieces of express and freight weighing 97,610 pounds, and received 1,092 pieces of express and freight weighing 75,797 pounds.

W. C. MENDENHALL,
Director.

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